DOCUMENT RESUME

ED 031 016 EC 004 008

Final Report to Social Rehabilitation Administration, Department of Health, Education, and Welfare, Washington, D.C.

Massachusetts Inst. of Tech., Cambridge. Sensory Aids Evaluation Development Center.

Spons Agency-Vocational Rehabilitation Administration (DHEW), Washington, D.C.

Pub Date 30 Apr 69

Note-75p.

EDRS Price MF-$0.50 HC-$3.85

Descriptors-Advisory Committees, Agency Role, Athletic Equipment, Braille, Computers, Electronic Equipment, Equipment Evaluation, *Exceptional Child Services, Magnetic Tapes, Mobility Aids, Pilot Projects, Sensory Aids, *Visually Handicapped

Identifiers-DOTSYS, Electrified Perkins Brailler, Lindsay Russell Path Sounder, Sound Source Ball

Projects and activities reviewed include the DOTSYS production of the first braille book from teletypsetter input, the use of DOTSYS, mechanical and electronic features of the high speed braille embosser developed at the Massachusetts Institute of Technology, and the pilot demonstration program for Perkins School for the Blind. Also surveyed are the following: the crooked handle folding cane project (design changes on the cane and evaluation process and questionnaire); the electrified Perkins brailler (explanation and development, electronic design, and mechanical features); the path sounder; and the sound source ball. Proposed work for calender year 1969 is outlined including the embosser field test and evaluation, straight handle folding cane, electrified Perkins brailler evaluation, path sounder evaluation, and sound source ball demonstration. Also summarized are the administrative structure; industrial cooperation with the center; seminars, presentations, conferences, and publications; and special conferences. Seven appendixes are provided. (JD)

ED031016

FINAL REPORT

to

SOCIAL REHABILITATION ADMINISTRATION
DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Washington, D.C.

of work done under Contract SAV-1057-67

for the period

1 December 1967 through 31 December 1968

from

THE SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER

Massachusetts Institute of Technology

292 Main Street
Cambridge, Massachusetts 02142

30 April 1969

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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from

THE SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER

Massachusetts Institute of Technology

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I. Preface

As the newly appointed director of the Center for Sensory Aids Evaluation and Development it was my responsibility to carry on with the traditional work established by the initial contract with Health, Education and Welfare, Vocational Rehabilitation Administration. The work undertaken by the Center has been documented in the previous final reports, conference proceedings, articles, papers and so forth. M.I.T.'s involvement in the area of sensory aids in general is a long and impressive one and the Center has been continuing in this same tradition in the specialized area of sensory aids for the blind.

The initial phase of activities was to review the programs, commitments, and obligations of the fiscal year contracts. The second task facing the new director was to re-establish the lines of communication broken by the unfortunate death of John K. Dupress, the former managing director. After these tasks were initiated the Center was once again on its way to fulfilling its duties as a leader in the field of sensory aids for the blind. The achievements of the Center are noted and reviewed in this report.

The accomplishments are broad in scope and significant in meaning. The uniqueness of the Center is that it is able to tackle and cope with a large variety of problems and projects which require the skills of a host of disciplines. These disciplines require the involvement of engineering, research, development, evaluation, consultation, documentation, education, and the dissemination of information.

The current activities were performed with the able assistance of the Center staff and through the expert help of the consultants. I am particularly indebted to the tireless assistance of Professor Robert W. Mann, of

the Mechanical Engineering Department at M.I.T., who is also chairman of the Steering Committee. Mr. George F. Dalrymple should be commended for his loyal participation as staff electronics engineer and helping the Center meet its goals in a difficult year. I also extend my appreciation to the very able administrative secretary, Mrs. Chantal Teller for her support to the Center's activities. In conclusion the Center and its staff look forward to promising years of activity and devoted service to the blind.

Vito A. Proscia
Director

II. Introduction

The Sensory Aids Evaluation and Development Center was established on September 1, 1964, under Contract SAV-1036-65 from the Vocational Rehabilitation Administration of the Department of Health, Education and Welfare. Members of the Staff of the Center include:

Mr. Vito A. Proscia, Director

Mr. George F. Dalrymple, Electrical Engineer

Mrs. Chantal Teller, Administrative Secretary

Mr. Norman Berube, Mechanical Technician

Mr. Alexander Glimcher, Electrical Technician

In addition to the regular staff members, the following persons performed work on specific projects (on a part-time basis) during the fourth contract year:

Mr. Murray Burnstine, Mechanical Engineer

Mr. Peter Duran, Mathematician

Mr. Lindsay Russell, Electrical Engineer

Mr. Ranulf Gras, Mechanical Engineer

Mr. and Mrs. Joseph Schack, Computer Programming

Mr. John Burke, Consultant Peripatologist

Mr. William Curtis, Consultant Peripatologist

Mr. Paul Maccarrone, Layout Draftsman

Mr. Ernest Johnson, Engineering Assistant

The Steering and National Advisory Committee provide necessary leadership and advice.

The scope of activities, as outlined in the initial contract, is as follows:

"The Center's activities consist of the following: (1) Evaluation of existing sensory aids and devices; (2) Location of new and promising aids for evaluation; (3) To encourage others to develop new aids which then can be submitted for production engineering at the Center; (4) In conjunction with the above, but to a lesser degree, development of new sensory aids for the blind; (5) Development of training principles and techniques for blind users of the sensory aids; (6) Behavioral research with blind users under field conditions; and (7) Development of objective standards to evaluate such devices.

Basic research and development will not constitute a major activity of the Center."

During the first contract year, the Center concentrated on staffing, facilities, laboratory equipment, arrangements with rehabilitation agencies and local manufacturers, and reliability engineering of prototypes.

During the second and third years, emphasis was placed on final field testing, production engineering, and negotiations with rehabilitation facilities for applications.

During the fourth contract year emphasis was placed on the development of the evaluation process and objective standards for the evaluation of existing devices. In addition a significant contribution was made in the demonstration of the feasibility of the current technology in sensory aids communication systems.

III. Projects and Activities

DOTSYS and The East Indiaman

The Braille edition of THE EAST INDIAMAN, by Ellis K. Meacham, (Little Brown and Co.), the first to be produced from teletypesetter input, was published in November, 1968, only a few weeks after the ink-print edition. The master Braille plates were produced with a minimum of human intervention, using a series of computer programs. The procedure can be described in three parts:

1. Conversion of the TTS codes into BCD codes and the insertion of the special format codes required for Braille.
2. Editing and correcting the BCD tape thus created.
3. Translation of the BCD tape into Grade II Braille.

The TTS input tape was translated to a formatted BCD tape by a modified DOTSYS system of programs. (For a detailed description of DOTSYS see 'PROCEEDINGS, BRAILLE RESEARCH AND DEVELOPMENT CONFERENCE[1], NOVEMBER 18, 1966'.) The following boxes were used: INBOX, TELCON, UNICON and UNIPER. These programs, originally written to operate on the CTSS system at M.I.T., were modified for the 709 at the American Printing House for the Blind. This involved rewriting those parts of the programs which were CTSS-dependent.

The UNICON box was rewritten and expanded to perform some of the function formerly handled by TELCON and TELCON was thereby considerably simplified. A major objective of DOTSYS is to minimize the reprogramming required to handle new forms of input and output. The UNICON box is independent of the medium which supplies its input. It is perman-

ent section of DOTSYS which performs the analysis and interpretation necessary to conform to the Braille rules. TELCON is just one of a possible set of conversion program designed to translate compositors media into Universal code. There could be boxes written to convert Monotype, Linofilm, etc. Each of these boxes would be independent of the Braille conventions and would perform only that interpretation required because of the particular typesetting equipment and the conventions which govern its use.

For example, the TELCON program performs a rather simple analysis to determine whether a particular letter is a capital or lower case and passes the appropriate Universal code to the UNICON box. UNICON performs a more complex analysis to determine whether a whole word, a portion of a word or only the first letter is capitalized to supply the correct BCD code.

The general flow chart on page 9a illustrates the operations, machine and manual, which were performed in the course of producing the Braille plates. As shown there, the six channel paper tape which had been used to set the first galleys for THE EAST INDIAMAN was copied onto magnetic tape. This step, performed in New York on an IBM 360/40 was necessary because the APH 709 has no paper tape reading facility. (Ironically, this operation which is technically the simplest, took an inordinate amount of time. Both the TTS tape and APH's 200 bit-per-inch magnetic tape are, in a sense, non-standard in terms of current technology and finding the appropriate machine configuration to accomplish the conversion proved quite difficult.)

The magnetic tape containing the TTS codes served as input to the modified DOTSYS which produced an intermediate BCD tape and a line-numbered listing suitable for editing. A sample of this listing and of the input from which it was created is shown on pages 9a-9e. This first phase would remain essentially unchanged for producing any other book which had been set by paper tape controlled line-casting equipment. To publish a Braille edition from another composition medium would require that TELCON be replaced with another box. The initial conversion step might or might not be necessary.

Phase two, the editing phase, would remain unchanged no matter what sort of compositors tape is used. The number of iterations through the editing procedure vary depending on the completeness and correctness of the tape. In the case of EAST INDIAMAN the paper tape was used to set the first galley proofs. From that point corrections to subsequent galleys and page proofs were made by hand in the metal and these corrections had to be detected and made on the intermediate BCD tape.

As shown in the flow chart, the EDIT program merges correction cards and the intermediate tape to produce a new tape and a listing. The first step in editing involves reading the BCD listing against copy to locate errors. In the hope that it would simplify the proof-reading task, a set of galleys were obtained from the publisher. Their corrections which were pencilled on the margins were the first made to the intermediate tape. Unfortunately, the galleys at our disposal were not those which had been run from the tape, but had been partially corrected. Apparently, in the course of making certain corrections, other errors were made, leading to a rather confusing situation; there were errors

noted on the galleys which did not appear on the listing of the intermediate tape, and errors on that listing which were no longer in the galleys. After the first set of corrections were made the corrected tape was proof-read against the inkprint copy of the book.

A new box, called EDIT, was added to the system to facilitate error correction. This program reads correction cards, locates and changes the erroneous information on the intermediate BCD tape and writes a new tape incorporating the changes. Under console control the new tape may be printed completely or in part. The following correction statements are permitted:

1. LINE n: This indicates the number of the line to be changed by one of the following statements. All the lines preceeding this one are copied from the old intermediate tape onto the new one; then the proper correction is made. The line numbers are not actually stored on the tape but are re-calculated during each run. The number appears on the listing for every fifth line and lines which have been changed are flagged with asterisks.

2. CHANGE /xxx/yyy/: This causes the character string 'xxx' to be replaced by 'yyy'. The two strings need not be equal in length. A consistent separator character must be used within a given CHANGE card and it must appear three times. CHANGE may be used to delete, change, add or rearrange characters within a line. For example:

   CHANGE /teh/the/ CHANGE /tothe/to the/

CHANGE /thee/the/ CHANGE /the//

CHANGE /th/the/ CHANGE /he/the/

CHANGE /th e/the/ CHANGE /te/the/

The correction will be made to the first occurrence of the 'xxx' string in the line.

3. DELETE n: This will delete the nth line. Subsequent lines will be re-numbered.

4. RETYPE xxx: The entire line indicated by the preceeding LINE card will be replaced by the character string 'xxx'.

5. INSERT xxx: The character string 'xxx' will be inserted as a whole line, in front of the line indicated on the preceeding LINE card.

It is interesting and gratifying to note that the proof-reading and error-correction proceeded quite efficiently, despite the fact that the Printing House personnel involved had had no prior experience with this kind of work. Because there was some concern about how quickly they would learn the techniques required, it was decided that only two of the four Braille volumes would be edited in this fashion. The balance of the book was corrected by key-verifying the cards which were punched from the intermediate BCD tape. It is difficult and unfair to compare these two procedures. However, the general impression was that the new method worked quite well and could be expected to become even more efficient with practice, some modifications to the EDIT box, and, of course, cleaner input tapes.

The third phase was the translation of the corrected BCD tape

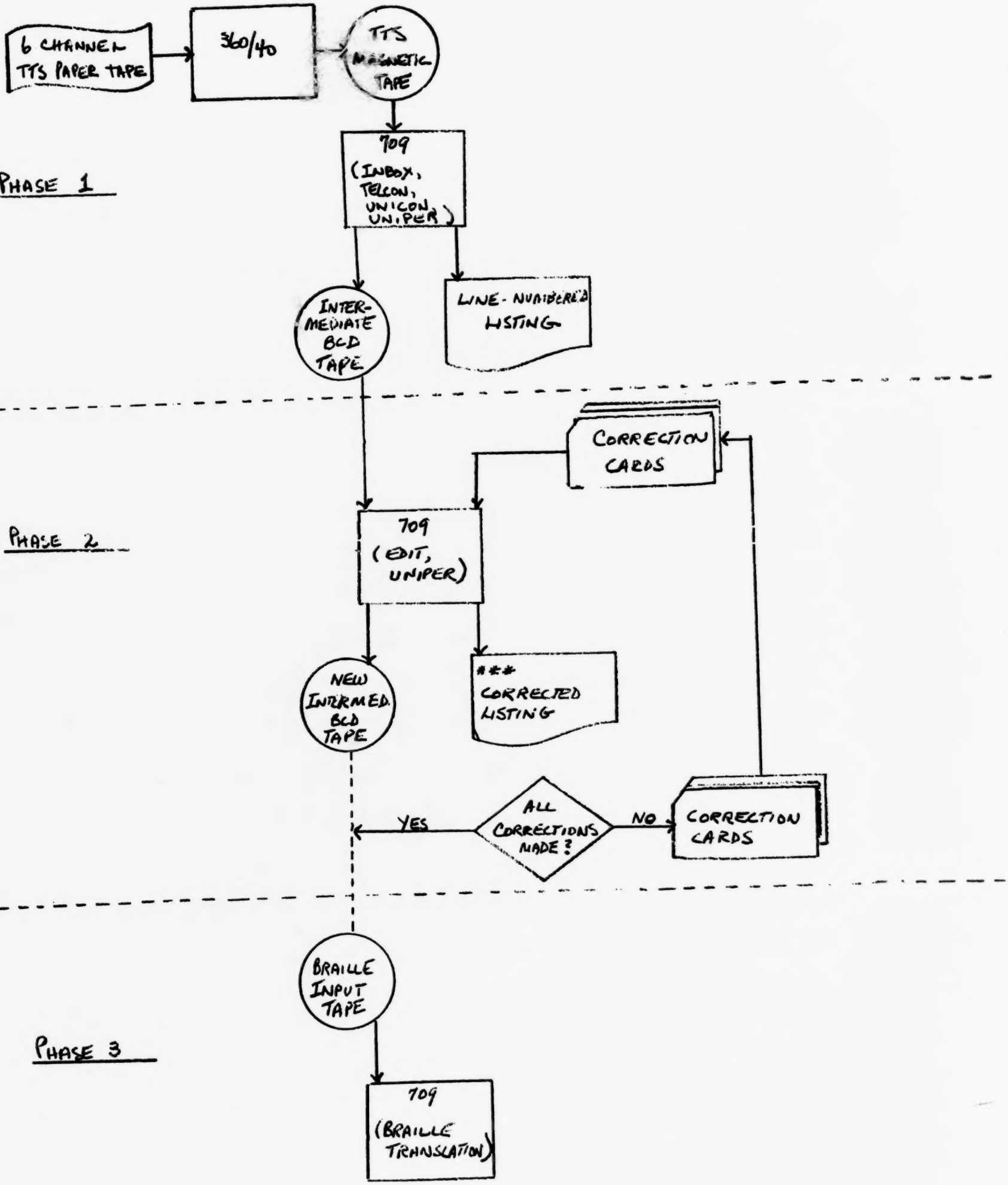
to Braille using the Braille Translation program which has been operating at the American Printing House for several years. Because DOTSYS supplies the format code and special character codes usually added to the text by the key-punch operator, this BCD tape 'looked' the same as it would had it been produced by keypunching. Thus, the translation phase, and the subsequent steps in the production of the book itself were those which have become conventional at the Printing House.

This project encountered at least as many - and probably more - stumbling blocks as one would expect in any pioneering system. In addition to the problems already indicated, the final debugging of the new boxes (which could not be done until the magnetic input tape was available) was performed under great pressure. Withal, we feel that this was a successful and important 'first'. The experience thus gained plus the program modifications outlined below will enable future publications to proceed more rapidly and smoothly.

In order to speed and simplify the editing procedure, we propose that the EDIT program be expanded and refined. The modified box would eliminate the need for a separate LINE card, permit making more than one CHANGE within a given line, permit making a CHANGE to a line which has just been INSERTed or CHANGEd, etc. In addition, the UNIPER box which prints the intermediate BCD tape would be modified to flag paragraph beginnings and other special format codes so that they would be easier to locate.

Some of the errors which had to be corrected manually could be recognized by a computer program. For this reason we propose adding a

new box, or more accurately a part, called PRUNE which would be a PRe-UNicon Editor. PRUNE would be concerned with re-ordering the input stream and correcting it so that it makes more sense for Braille translation.


6 CHANNEL TTS PAPER TAPE
360/40
TTS MAGNETIC TAPE
709 (INBOX, TELCON, UNICON, UNIPER)
PHASE 1
INTER-MEDIATE BCD TAPE
LINE-NUMBERED LISTING
CORRECTION CARDS
709 (EDIT, UNIPER)
PHASE 2
NEW INTERMED. BCD TAPE
***
CORRECTED LISTING
YES
ALL CORRECTIONS MADE?
NO
CORRECTION CARDS
BRAILLE INPUT TAPE
PHASE 3
709 (BRAILLE TRANSLATION)

GALLEY 1
Little, Brown, East Indiaman 85-4212 10 Electra on 12x23hf

Guide: Chapter 1
Only a single captain on the active list of the Naval Service of the Honourable East India Company was in England this raw January morning. This was by no means remarkable, since the normal theater of operations of the service was half a world away and its officers had little occasion to come to Britain except as invalids or upon retirement—if they were fortunate enough to survive so long.

The popular name of the service was the Bombay Marine, often called with grudging admiration by officers of the Royal Navy, "The Bombay Buccaneers." The Marine was the only private navy in the world and was employed by the Honourable Company to protect its far-flung operations, which extended from the Red Sea and Persian Gulf, across the Indian Ocean and the crowded East Indian archipelago, to China. It was a service small in numbers, but already possessed of a hundred and ninety-three years of honorable tradition in this year of 1806. While it sailed frigates of as many as fifty-six guns, it was more often concerned with ketches, snows, brigs, sloops, schooners and grabs of shoal draft, carrying six to fourteen guns, which met and defeated French, Dutch, Portuguese, Spanish, Chinese, Arab, Malay and Moro ships and forces under adverse conditions.

The officers of the Marine served not only at sea but as diplomats in remote areas among savage peoples; as commanders of units in combined operations ashore with army siege trains; as expeditionary forces with elements of the Marine Battalion; and as surveyors charting the eastern seas. Few sprigs of the nobility or sons of landed gentry chose the arduous service of the Bombay Marine as a career in preference to His Majesty's Navy or Army. Some officer candidates entered as volunteers or midshipmen; others rose from the ranks if they possessed sufficient education and ability. Cannon and musket balls, tropical fevers, accident and shipwreck, provided a constant attrition in the lower commissioned ranks and left promotion to captain in the Service largely a matter of fortune and influence in the Court of Directors of the Company.

This one captain in the Bombay Marine was in London for the first time in nine years by pure chance. He bore the somewhat pretentious name of Percival Merewether, but had risen to his exalted rank from humble origins in life by way of the lower deck. He was a man of a little more than middle height, broad in the shoulders, not yet stooped by life below decks, and carried himself with the alert air of agile grace often seen in the practiced seaman. His face, with lively blue eyes under dark brown hair, was unremarkable except for a broken nose, badly set, a long disfiguring scar along his right jawline, a missing right earlobe and blue-tinged powder burns on his cheek, the combination of which gave him an expression of ruthless determination. He had held the rank of captain less than twenty-four hours, though sixteen of his twenty-eight years had been spent at sea in the service of the company.

Yesterday, Merewether had been a first lieutenant in the Service, junior to at least a score of other officers of vast experience, courage and ability, equally deserving of promotion to the one vacancy in the list of captains. It had been his fortune to distinguish himself under the eyes of an Indiaman's captain, who was

/@@@B*W53/005K*N 25,5%L□ITTLE, 1%B□ROWN, 1%E□AST 1%I□NDIAMAN,
@10 1%E□LECTRA 1ON 112X23HF33/
@%M□ARIE 13-2633/
@/
@%G□UIDE%. 1C□HAPTER 1133/
@%O□NLY A SINGLE CAPTAIN ON THE ACTIVE LIST OF THE %N□AVAL %S□E
@%H□ONOURABLE %E□AST %I□NDIA %C□OMPANY WAS IN %E□NGLAND THIS RA
@MORNING. %T□HIS WAS BY NO MEANS REMARKABLE, SINCE THE NORMAL
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@O%1□CERS HAD LITTLE OCCASION TO COME TO %B□RITAIN EXCEPT AS IN
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@FRIGATES OF AS MANY AS %9□FTY-SIX GUNS, IT WAS MORE OFTEN CONC
@WITH KETCHES, SNOWS, BRIGS, SLOOPS, SCHOONERS AND GRABS OF SHO
@DRAFT, CARRYING SIX TO FOURTEEN GUNS, WHICH MET AND DEFEATED
@%F□RENCH, %D□UTCH, %P□ORTUGUESE, %S□PANISH, %C□HINESE, %A□RAB,
@%M□ORO 1SHIPS 1AND 1FORCES 1UNDER 1ADVERSE 1CONDITIONS.33/
@3%T□HE O%1□CERS OF THE %M□ARINE SERVED NOT ONLY AT SEA BUT AS
@MATS IN REMOTE AREAS AMONG SAVAGE PEOPLES. AS COMMANDERS OF
@UNITS IN COMBINED OPERATIONS ASHORE, WITH ARMY SIEGE TRAINS. A
@EXPEDITIONARY FORCES WITH ELEMENTS OF THE %M□ARINE %B□ATTALION
@AS SURVEYORS CHARTING THE EASTERN SEAS. %F□EW SPRIGS OF THE NO
@SONS OF LANDED GENTRY CHOSE THE ARDUOUS SERVICE OF THE %B□OMBA
@%M□ARINE AS A CAREER IN PREFERENCE TO %H□IS %M□AJESTY,S %N□AVY
@%S□OME O%1□CER CANDIDATES ENTERED AS VOLUNTEERS OR MIDSHIPMEN.
@OTHERS ROSE FROM THE RANKS IF THEY POSSESSED SU%1□CIENT EDUCAT
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@3%T□HIS ONE CAPTAIN IN THE %B□OMBAY %M□ARINE WAS IN% L□ONDON F
@%9□RST TIME IN NINE YEARS BY PURE CHANCE. %H□E BORE THE SOMEWH
@PRETENTIOUS NAME OF %P□ERCIVAL %M□EREWETHER, BUT HAD RISEN TO
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@%H□IS FACE, WITH LIVELY BLUE EYES UNDER DARK BROWN HAIR, WAS U
@MARKABLE EXCEPT FOR A BROKEN NOSE, BADLY SET, A LONG DIS%9□GUR
@SCAR ALONG HIS RIGHT JAWLINE, A MISSING RIGHT EARLOBE AND BLUI
@TINGED POWDER BURNS ON HIS CHEEK, THE COMBINATION OF WHICH GAV
@HIM AN EXPRESSION OF RUTHLESS DETERMINATION. %H□E HAD HELD THI
@RANK OF CAPTAIN LESS THAN TWENTY-FOUR HOURS, THOUGH SIXTEEN OF
@TWENTY-EIGHT YEARS HAD BEEN SPENT AT SEA IN THE SERVICE OF THI
@COMPANY.33/
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@ICE, JUNIOR TO AT LEAST A SCORE OF OTHER O%1□CERS OF VAST EXPI

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300516343436020816071F180A0C1004203032393534343602083602081B0B1F]
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0A0F0C0E10041918140405180916041804190304091204181918150418061204C
090C0101091004030E0E18140C03060401030040E03071004010304 1B131F0A0CC
18090C1214040304020820 1C0D0306040A10010C0A10071006011B2C1F0C160401C
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0510041B0A1F0315180904 1B061F180F15260208 1B2222011F051 0041B131F03C
2222041B011F0510041B071F180A0C0610041918140401051C04030609150400C
10041903 0A0912041806120419181404100 70D0903151012041315040105100 4]
0D181F32020806150401030400D0A0301100E01040C0114041618 0A321B2D1F1CC
0E0504101701100612101204160A0307040105100208 1B0A1F1012041B141F10]
1F1C0916260418 0E0A0314140401051004 1B0C1F06120C1806041B031F0E1C18C
041B101F18140104 1B0C1F06120C18060418 0A0E050C0D1009180303260401030
04180414100A0F0C0E10041407180909020 80C060406 1C07131C0A142604131CC
12040316041804051C06120A1012041806120406 0C0610011532010 50A101002C
1004010A18120C010C0306040C060401050C1404151018 0A04031604372C2D35]
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0D09031F32020807180114040C06040A10070301100418 0A1018140418070306C
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```

```
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142604180E0E0C121006010208180612041405 0C0D190A100E1E26040D0A030F
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```

```
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0A0412100E1E2702081B051F10041918140418040718060403160418041F090C
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10120413150409 0C161004131009031904121 00E1E1426041806120 40E180A0A
```

$EL FM5 $EL 0054N 25,b=LITTLE, =BROWN, =EAST =INDIAMAN,
$EL 10 =ELECTRA ON 12X23HF $EL =MARIA 3-26 $EL $EL =GUIDE
=CHAPTER 1 $EL =ONLY A SINGLE CAPTAIN ON THE ACTIVE LIST
=NAVAL =SERVICE OF THE =HONOURABLE =EAST =INDIA =COMPANY
=ENGLAND THIS RAW =JANUARY MORNING. =THIS WAS BY NO MEANS
REMARKABLE, SINCE THE NORMAL THEATER OF OPERATIONS OF THE
WAS HALF A WORLD AWAY AND ITS OFFICERS HAD LITTLE OCCASION
COME TO =BRITAIN EXCEPT AS INVALIDS OR UPON RETIREMENT--IF
WERE FORTUNATE ENOUGH TO SURVIVE SO LONG. $EL $PAR =THE PO
NAME OF THE SERVICE WAS THE =BOMBAY =MARINE, OFTEN CALLED
GRUDGING ADMIRATION BY OFFICERS OF THE =ROYAL =NAVY, =(=TH
=BOMBAY =BUCCANEERS.=) =THE =MARINE WAS THE ONLY PRIVATE
THE WORLD AND WAS EMPLOYED BY THE =HONOURABLE =COMPANY TO
ITS FAR-FLUNG OPERATIONS, WHICH EXTENDED FROM THE =RED =SE
=PERSIAN =GULF, ACROSS THE =INDIAN =OCEAN AND THE CROWDED
=INDIAN ARCHIPELAGO, TO =CHINA. =IT WAS A SERVICE SMALL IN
NUMBERS, BUT ALREADY POSSESSED OF A HUNDRED AND NINETY-THI
YEARS OF HONORABLE TRADITION IN THIS YEAR OF 1806. =WHILE
SAILED FRIGATES OF AS MANY AS FIFTY-SIX GUNS, IT WAS MORE
CONCERNED WITH KETCHES, SNOWS, BRIGS, SLOOPS, SCHOONERS AN
OF SHOAL DRAFT, CARRYING SIX TO FOURTEEN GUNS, WHICH MET
DEFEATED =FRENCH, =DUTCH, =PORTUGUESE, =SPANISH, =CHINESE
=MALAY AND =MORO SHIPS AND FORCES UNDER ADVERSE CONDITIONS
$PAR =THE OFFICERS OF THE =MARINE SERVED NOT ONLY AT SEA
DIPLOMATS IN REMOTE AREAS AMONG SAVAGE PEOPLES=, AS COMMAN
UNITS IN COMBINED OPERATIONS ASHORE, WITH ARMY SIEGE TRAI
EXPEDITIONARY FORCES WITH ELEMENTS OF THE =MARINE =BATTAL
AND AS SURVEYORS CHARTING THE EASTERN SEAS. =FEW SPRIGS OF
NOBILITY OR SONS OF LANDED GENTRY CHOSE THE ARDUOUS SERVI
THE =BOMBAY =MARINE AS A CAREER IN PREFERENCE TO =HIS =MA
=NAVY OR =ARMY. =SOME OFFICER CANDIDATES ENTERED AS VOLUN
MIDSHIPMEN=, OTHERS ROSE FROM THE RANKS IF THEY POSSESSED
SUFFICIENT EDUCATION AND ABILITY. =CANNON AND MUSKET BALL
TROPICAL FEVERS, ACCIDENT AND SHIPWRECK, PROVIDED A CONST
ATTRITION IN THE LOWER COMMISSIONED RANKS AND LEFT PROMOT
CAPTAIN IN THE =SERVICE LARGELY A MATTER OF FORTUNE AND I
IN THE =COURT OF =DIRECTORS OF THE =COMPANY. $EL $PAR =TH
CAPTAIN IN THE =BOMBAY =MARINE WAS IN =LONDON FOR THE FIR
IN NINE YEARS BY PURE CHANCE. =HE BORE THE SOMEWHAT PRETE
NAME OF =PERCIVAL =MEREWETHER, BUT HAD RISEN TO HIS EXALT
FROM HUMBLE ORIGINS IN LIFE BY WAY OF THE LOWER DECK. =HE
MAN OF A LITTLE MORE THAN MIDDLE HEIGHT, BROAD IN THE SHO
NOT YET STOOPED BY LIFE BELOW DECKS, AND CARRIED HIMSELF
ALERT AIR OF AGILE GRACE OFTEN SEEN IN THE PRACTICED SEAM
FACE, WITH LIVELY BLUE EYES UNDER DARK BROWN HAIR, WAS
UNREMARKABLE EXCEPT FOR A BROKEN NOSE, BADLY SET, A LONG
DISFIGURING SCAR ALONG HIS RIGHT JAWLINE, A MISSING RIGHT
AND BLUETINGED POWDER BURNS ON HIS CHEEK, THE COMBINATION
WHICH GAVE HIM AN EXPRESSION OF RUTHLESS DETERMINATION. =
HELD THE RANK OF CAPTAIN LESS THAN TWENTY-FOUR HOURS, THO
SIXTEEN OF HIS TWENTY-EIGHT YEARS HAD BEEN SPENT AT SEA I
SERVICE OF THE COMPANY. $EL $PAR =YESTERDAY, =MEREWETHER
A FIRST LIEUTENANT IN THE =SERVICE, JUNIOR TO AT LEAST A
OTHER OFFICERS OF VAST EXPERIENCE, COURAGE AND ABILITY, E
DESERVING OF PROMOTION TO THE ONE VACANCY IN THE LIST OF
CAPTAINS. =IT HAD BEEN HIS FORTUNE TO DISTINGUISH HIMSELF
THE EYES OF AN =INDIAMAN, CAPTAIN, AND HAD ALSO =SHIP$,
=HUSBAND OF THREE OTHER =INDIAMEN, OWNER OF A LARGE NUMBER
SHARES IN THE =COMPANY AND A MEMBER OF THE =COURT OF =DIR
=MEREWETHER HAD WAITED ON THE =NEW =YEARS SESSION OF TH
OF =DIRECTORS OUTSIDE THE MASSIVE CHAMBER IN =EAST =INDIA
IN =LEADENHALL =STREET YESTERDAY, SUBJECT TO INTERVIEW IF
=COURT SO DESIRED, IN FULL-DRESS UNIFORM AS REQUIRED BY
REGULATIONS, HAVING IN HIS BLUE COAT WITH BUFF LAPELS, SI

HOOK is the program which is concerned with configuring the system for a particular purpose. For example, to print typewritten dots on a terminal from typed input it is necessary to use TYPEIN, BRAILL and DOTPR. This information would be furnished to HOOK.

HOOK creates the linkages between boxes by placing the appropriate XEC OUTER instruction in the input terminal of each box. HOOK also calls the reset routine, if any, of each box, and then transfers control to the final or output box, which then starts the processing.

In order to accomplish HOOK's function each box must provide an ENTRY card and a table of contents as follows:

```
          ENTRY          Name of box     (e.g. UNICON)
          ...
          ...
          ...
INTER     CLS            =0
OUTER     TSX            MYSELF,4
UNICON    TRA            RESET or TRA    1,4 if resetting is
                                         not necessary
```

The table of contents may be located anywhere in the program, while the ENTRY card, of course, must be one of the first cards of the program.

The TSX instruction of the OUTER (OUter TERminal) must transfer to a location within the box which saves the address in index register 4 in order to return correctly when the box has completed processing and has information to output. Because the calling box has performed an

XEC the proper return location is placed in index register 4 by OUTER's TSX.

HOOK requires a list of programs to be reset and linked together. This is furnished by modifying a card in the HOOK FAP deck and reassembling. The card is labeled HOOK and a sample follows:

```
HOOK    RESET    (OUTBOX,FORMAT,BRAILL,UNICON,TELCON,INBOX)
```

RESET is a macro which generates a list of TSXs to the instruction which transfers to the reset routines. Each RESET must end with a TRA 1,4. After resetting HOOK then creates the XEC instructions using the information in the transfer vector created by assembly. Execution of a particular configuration is accomplished by loading HOOK and the desired boxes and then transferring control to HOOK.

Please note the details of the HOOK card. The label must be HOOK, the op code must be RESET. The box names are separated by commas and enclosed within parentheses. There must be at least two boxes.

One final note on configuration which requires the use of the BRAILL box. At load time BRAILL must be loaded followed directly by SMALLT and TABLE i.e. LOAD BRAILL SMALLT TABLE HOOK UNICON INBOX etc. This is necessary because the TABLE is referenced by its distance from the last location in BRAILL.

This document is intended to read in conjunction with the description of DOTSYS given in the Proceedings of the Braille Research and Development Conference[2] dated 18 November 1966 and sponsored by the Sensory Aids Evaluation and Development Center, M.I.T.

M.I.T. High Speed Braille Embosser

Mechanical Features

A high speed braille embossing system has been under development at the SAEDC and the Mechanical Engineering Department at M.I.T. since 1960. A detailed historical account including the disposition of assembled units can be found in our previous documents. A grant from the Hartford Foundation running through June 1970 is providing support for the program. Since 1967 the SAEDC has utilized design,drafting and shop facilities of the M.I.T. Instrumentation Laboratory.

Out of this cooperative effort has evolved a much improved machine known as the IL or Model 3 Brailler. While the cost of some fabricated components has gone up, others have been replaced by parts which are now commercially available. Only the major design changes not previously reported are listed below.

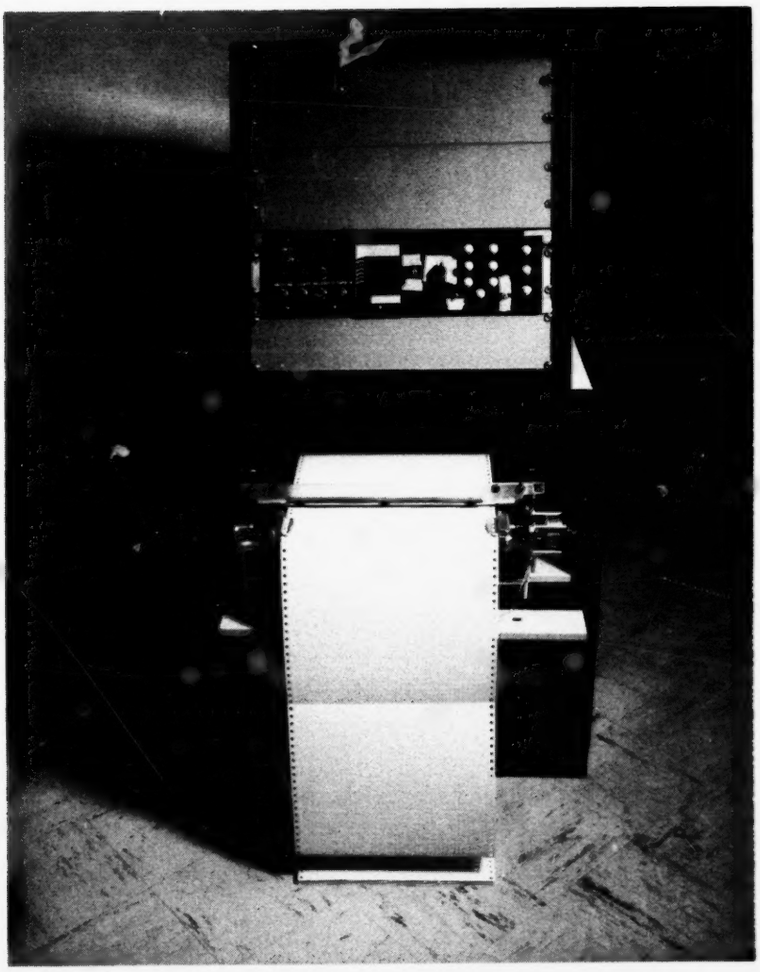
1. The crank-shaft cycle clutch has been replaced by a clutch-brake. To date we have tested these units to 6 million emboss cycles without failure.

2. The friction roller paper drive has been replaced by a paper tractor/digimotor drive.

3. The cam driven escapement has been replaced by a continuously driven 1/2 revolution gear set.

4. The escapement rack is displaced horizontally instead of vertically.

5. The embossing heads are located by a set of "V" ways instead of



M.I.T. High Speed Braille Embosser, Model 3

flat ways.

6. Ducting has been utilized to direct cooling air where required.

Electronic Features

The Mark 2 Electronics for the Model 3 has four modes of operation: Manual, Tape Reader, EQIDOT Exerciser, and BIDOT Exerciser. The manual mode permits embossing single or multiple dot cells by switches on the control panel. In the tape reader mode, a Friden SP-2 tape reader controls the embosser. The EQIDOT Exerciser produces a braille pattern that has all possible cell combinations (except space). This pattern is generated by a "Maximal Length" Shift Register. An option for Carriage Return after "for" is available. The BIDOT Exerciser has most of the test features described for the exerciser in the 1965 Final Report.

The electronics are constructed using Digital Equipment Co. R- and W- series computer modules. Several logic functions have been changed in conjunction with mechanical changes. The Carriage Return function is now performed by spacing to the end of the line. Previously it was performed by holding the rack down with a solenoid and letting the heads move freely until a head struck the "false tooth" on the rack.

The timing of the automatic Line Feed has been changed. In the earlier design the Line Feed was started by the head closing the start line switch. In the Model 3 the time of the automatic Line Feed is determined by a delay in the electronics. This delay is initiated by the pulse that triggers the cycle-clutch. The delay is the time it takes the platen to emboss and clear the pins. The circuit is enabled

by a head in the last cell holding the end-of-line switch closed.

The embosser has operated for short periods of time at 16 cells per second embossing from punched paper tape. Most of the embossing performed to date with the Model 3 has been at 16 cells per second using the exerciser modes, both EQIDOT and BIDOT.

Pilot Demonstration Program for Perkins School for the Blind

A test brailler, with most, but not all features of the Model 3 brailler was used to emboss 800 sheets (25 copies of 32 pages) of braille from punched paper tape. The input tape was prepared at Howe Press of Perkins School for the Blind using equipment developed at the American Printing House for the Blind. The material was part of a pamphlet on the American Revolution. Fifteen copies were given to high school history students at the Perkins School for the Blind. Only 11 errors could not be attributed to errors in the tape and brailler operation. This is one random error per 43.6 pages or 24 errors per million cells.

The purpose of the program was to demonstrate a possible application for limited copy braille duplication. The normal process of braille duplication requires the preparation and use of embossing plates to produce braille. However this demonstration showed that a single punched paper tape could be used to produce several copies or limited multiple copy runs of the required literary material, thereby substituting one paper tape for many zinc embossing plates. The pilot program also demonstrated the use for a

device which fills the gap between the large run braille printing system and the hand-copy braille production method. An added advantage shown by this pilot study is that the vehicle used for production, punched paper tape instead of zinc plates, is more easily stored in the case of the M.I.T. high speed braille embosser.

Crooked Handle Folding Cane and Evaluation

Since its founding in 1964 the M.I.T. SAEDC has been pursuing a development of folding canes. The learning process has been a long and tedious one, past reports have indicated and have been documented as to the effort and emphasis that has been placed in the evaluation and development of existing folding canes. Studies included testing of commercially available canes which are distributed and sold to the blind for mobility purposes. However, these canes do not meet with the rigid requirements specified by the M.I.T. studies in the area of folding canes as specified as early as the Final Report for fiscal year 1965-1966 for M.I.T. SAEDC. The requirements laid down by the Center state that the folding cane must be portable, light weight, durable, rigid when extended, balanced, economical and must have a life time of at least a year. The Center feels that the swaged tube central steel cable folding cane presently meets many of these specifications.

During the conference for mobility trainers and technologists[3] the Center was urged by the attendees to distribute the present config-

uration of the swaged tube central steel cable crooked handle folding cane for evaluation purposes to appropriate agencies and participants. Shortly after the conference the project was undertaken at the Center to manufacture and distribute 100 folding canes to interested evaluators. Chart I, Appendix 4, contains a list of the agencies that took part in this evaluation program and includes the number of folding canes distributed to each agency and also to a number of individuals.

Evaluation Process

A folding cane evaluation and distribution program was initiated at the Center early in 1968. The following steps were taken in order to insure distribution and evaluation of the folding cane: 1) drawings were prepared and sent out to vendors to bid on the manufacture of cane sections; 2) the cane parts were manufactured and returned to the Center, to be assembled into various length canes; 3) the participating agencies and individuals specified length of canes required for the subjects and also tips, see Chart II; 4) a cane package was assembled which included descriptive material, instructional material and questionnaires (Final Report, 1965-1966) for evaluation purposes; 5) cartons and packing materials were purchased for mailing purposes; 6) a maintenance facility was established at the Center for damaged or broken canes.

The procedure used in the evaluation consists of several steps:

1) A subject and a sighted advisor are selected. The subject must be an experienced cane traveler.

2) The cane is made to order for the subject, with lengths re-

stricted to even-numbered inches: 48, 50, 52 etc., with the choice of tips: the AFB glide tip or the nylon tip similar to the one used on the Veterans Administration Cane.

3) The sighted advisor following the illustrated instructions teaches the subject the correct techniques in folding and extending the cane.

4) The Legal Release, General Information Form, and a Pre-Test Questionnaire are filled out.

5) The subject uses the cane in his normal activities for approximately 2 months.

6) Broken or damaged canes are returned within a day after they are received.

7) After this period the Post-Test Questionnaire is filled out to record the subject's response to, and his opinion of, the cane.

8) The cane is left with the subject as long as he submits periodic informal reports of his use of the cane to SAEDC.

The technical custody remains with the Sensory Aids Center. Canes that are not being actively used are recalled. The recalled ones have been reissued to additional subjects.

Design Changes on the Folding Cane

All canes returned to the Center were examined by design personnel before the canes were repaired. In many instances, wear marks not related to the more obvious defects indicated the user was not

properly instructed in the assembly and disassembly of the cane. Several returned canes were damaged by abuses which no design could eliminate, i.e. "run over by automobile", "bashed against steps by naughty child", etc. Based on field failures the following changes were made.

The Center purchased a better designed ferrule crimping tool to secure the loops at either end of the central steel cable. The new tool features dies that cannot be closed beyond the optimum distance required for maximum cable strength.

The roll pin cable attachment design at the lower cane section has been replaced by a tapered aluminum plug. The described design change improves cane balance, facilitates cane assembly and improves the exterior appearance of the cane.

Evaluation Questionnaires

The actual evaluation process is being conducted through the use of two forms: the Pre-Test Questionnaire, and the Post-Test Questionnaire. The first is answered by the subject before he is given the SAEDC folding cane and it is meant to determine his attitudes and opinions towards canes he has used in the past and toward cane travel in general. The main questions about past canes concern: durability, the material of which the canes were made, the material of which the tips were made, the presence or absence of reflectorized coating, compactness of the canes and whether they were folding or rigid. And finally a series of questions ask how the subject feels about the cane as a sign to others that he is blind. After completing this questionnaire the subject is

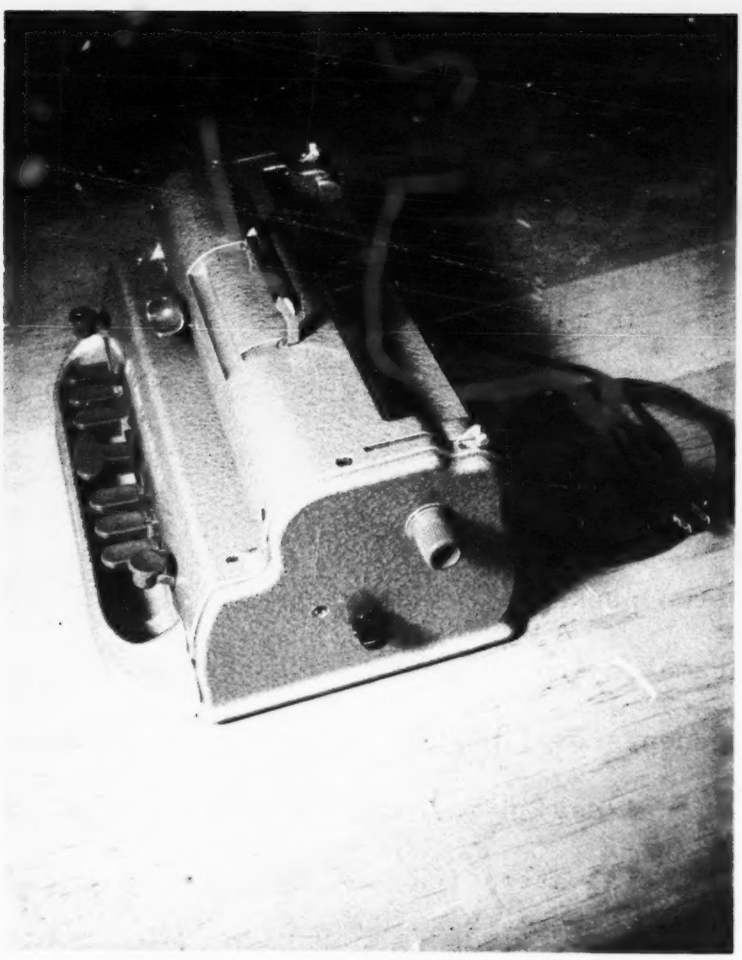
given a crooked handle folding cane, instructed in its use and asked to use it for a two month evaluation period. At this time the subject is asked to fill out the Post-Test Questionnaire. This questionnaire has as its main purpose to determine the attitudes and opinions of the subject on the cane independently and relative to his past canes. The questions about the folding cane concern: its rigidity, balance, ease of assembly and disassembly, compactness, durability, comfort of the grip, capacity to relay information along the shaft and comparative weight. Again the subject is asked how he feels about the cane as a sign to others that he is blind and whether the folding cane has made any difference to his feelings.

All the questionnaires have not yet been returned, so the results of the evaluation will only be available in calendar year 1969.

Electrified Perkins Brailler

Introduction

Many attempts have been made to electrically assist the manual effort input to the Perkins Brailler. However no attempts have been made to manufacture a Perkins Brailler which would incorporate an electrical assist feature. This document will not attempt to explain the whys and wherefores of the other efforts or to attempt explanation of any philosophy or technological features of other systems. Instead a description will be devoted to a program which the Center has undertaken



Electrified Perkins Brailler

and which is considered to be a straightforward solution to the electrification of a Perkins Brailler.

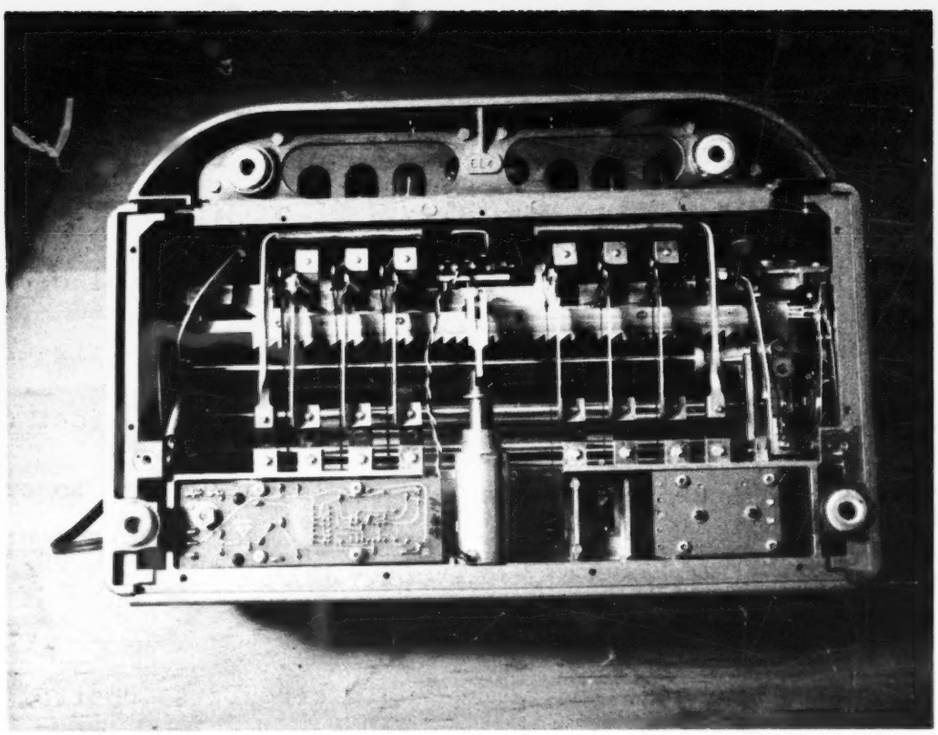
The Center initially attacked the problem of the electrification of the brailler by building a large electronic test package to pulse a solenoid which would drive a rack and platen. (This system was described in the 1966-1967 Final Report.) (The solenoid was selected and installed by Howe Press of Perkins School for the Blind.) Even though excellent braille was produced by this electronic test package it was evident that the size of the test module was too large for practical purposes. In mid 1968 a further development proceeded along the lines to design a small electronic package which would be housed in a carrying case and which could easily be connected via a cable to the brailler. However the two unit approach is undesirable since it would involve carrying two packages, an electronics pack and a braille writer. This approach became no longer necessary since electronic state of the art made new components available. An ensuing development was undertaken to bread board a final design which would then be incorporated in the brailler frame. Special attention was also given to hardening of strategic parts, which would otherwise be weakened by excessive forces applied to the machine; improving linkages between rack and solenoid; selection of a solenoid different from that proposed by Howe Press of Perkins School for the Blind; and mounting of the appropriate switches.

The basic design concept envisioned in this program was to maintain as many of the original design features of the machine as was possible. The design features which were established required that:

1) an electrical assist would be applied to replace the manual embossing effort; 2) the functions for the line-feed, back-space, and carriage return would remain as in the original brailler; 3) the electronics used would be self-contained in the machine; 4) the original carrying case would be used to store the machine; 5) some technique for controlling the electronics would be incorporated to help overcome some of the noise produced by applying excessive forces during embossing; 6) reliability and maintainability would be essential design features; 7) safety is a prime consideration; 8) a low cost brailler was considered to be the final goal.

The design parameters set forth in the above specifications have been realized in a limited run production of ten Perkins Electrified Braillers which will be made available for distribution and evaluation in fiscal 1969. The acceptability and utility of these machines will be tested by a select group of individuals covering a cross-section of braille activities and disciplines. The group will consist of students, professional workers and volunteer braillists. It is anticipated that this evaluation program will run for a period of one year in order that a large sampling of the blind and volunteer braillist population may be tested.

At the Ramada Inn conference of May 1967 complaints were voiced concerning the excessive noise produced by the snap action of the solenoid. Due to the variation in the tolerances of the components (electrical, mechanical and brailler production) it was difficult to make identical operating units. Therefore an external adjustment knob was



Electrified Perkins Brailler, with internal electronics visible

mounted to the end-plate of the brailler in order to compensate for the differences incurred in component variation. A secondary effect of the presence of the adjustment circuitry was to create a trade-off between noise created by solenoid action and acceptable braille display. Further attempts will be made to investigate other noise limiting substances or methods which may make the brailler even more attractive.

Electronics Design

The electronics uses a "Triac" as the switch. This is a bi-directional solid state device that conducts when it is triggered by a low level control pulse and turns off at the next reversal of the line voltage. A "one-shot" and gate is used to generate the trigger pulses from a fill-wave rectified signal. This provides the correct timing for the Triac trigger pulse. To supply sufficient energy to emboss the brailler requires one full cycle; therefore the triac must be triggered twice.

A series rheostat in the solenoid circuit to control the peak current and thereby the force is used to set the force level to the lowest usable point. The different grades of braille paper require varying amounts of force to emboss. By operating at the lowest reasonable force level both the wear and the noise level of the brailler can be minimized.

A "one-shot" is used to provide a 7 ms delay between the space bar switch closure and energizing the solenoid. This compensates for the time variation of key depression by the braillist. The embossing

action takes less than 16 ms and all embossing pins must be locked by the cams before the solenoid is energized.

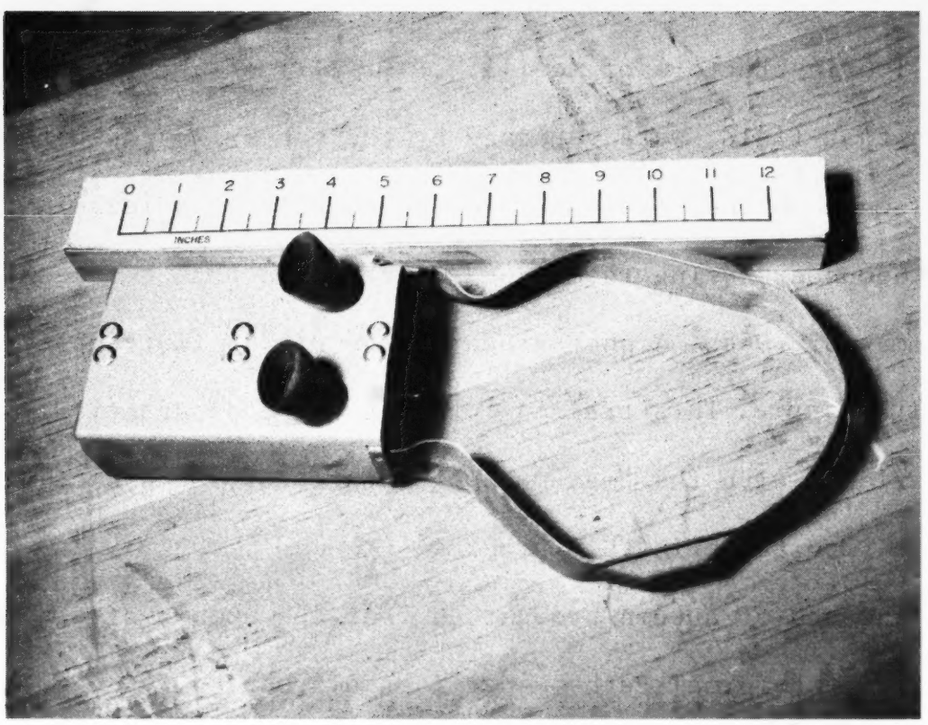
Mechanical Features

SAEDC personnel have assisted the manufacturer of the Perkins Brailler (Howe Press) in advancing their design concept of a solenoid assist to reduce the manual effort required at the keyboard. The Center's participation has been confined to the areas of design, preparation of engineering drawings, fabrication of electronic modules, and evaluation of assembled units. All mechanical assembly and adjustment operations were handled by Howe Press personnel. In general the design changes accomplished since last reported provided for mounting and actuator linkage and certain frame modifications necessary to mount the circuit boards within the existing brailler envelope.

The initial advantages of the solenoid assisted platen design (economy and simplicity) are trade offs for the high accelerations, snap action, and noise characteristic of solenoids. We do not plan to undertake a noise reduction program for the described machine until its durability has been demonstrated by actual use in the field.

Pathsounder

Reference is made to earlier annual reports for a detailed



Lindsay Russell Path Sounder, Model H

description of the Pathsounder, a small, chest-mounted sonar designed as a supplementary travel aid for cane users. It was noted in the immediately previous report that in the year coming up some further design refinement was to be made on the instrument and that the project had reached a stage wherein closer ties ought to be established with the cane traveling community. These objectives have been accomplished during the past year, with fairly encouraging results.

Two instructors of mobility, graduates of the Boston College program in that field, were retained by the Center as consultants, part-time. Between them they trained three blind cane travelers in the use of the Pathsounder, using redesigned instruments that became available in the summer of 1968. A photograph of one of the instruments is shown in the figure. This training project added substantially to the total experience with the "man-machine interface", an aspect obviously of dominant importance in this program.

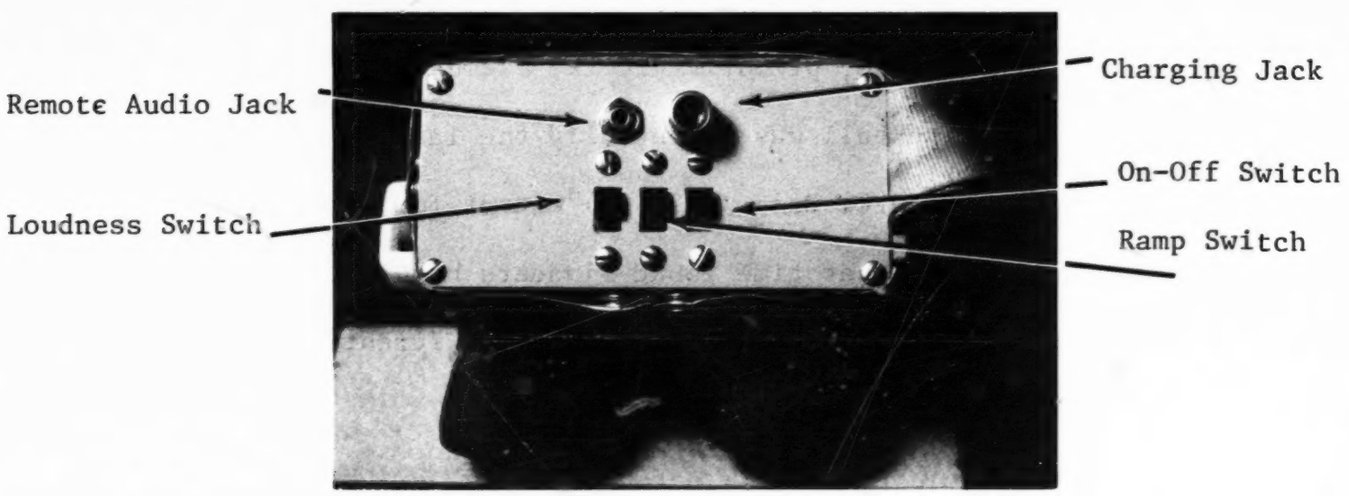
The end of autumn brought to four the number of cane users who have received formal Pathsounder instructions. Of these, one has left the country and another, whose progress was impeded by a number of technical problems, was not interested in continuing with the aid.

The third, a college sophomore, has retained the instrument he trained with and is using it regularly in commuting from a suburban home to a city college via public transportation. He is one of the most skilled users, and has many times co-operated with the Center staff by navigating through shopping crowds, trailed by his instructor in the company of teachers-in-training, visiting mobility workers, etc.

The fourth trainee, a high school student just turned sixteen, is finishing his lesson program - both cane and Pathsounder - and is probably the closest of the four to being describable as an "enthusiast". Significantly, perhaps, his training with the aid began along with his general travel lessons, in contrast to the others, who were fairly experienced travelers with well-developed habits before being introduced to the Pathsounder. He sought permission to retain the instrument for use on his own, rather than just at lesson time, and is reported by his instructor to be using it very regularly in his home town for shopping trips, recreational travel, etc.

It has become apparent that instruments should be available for retention by some students after their lesson program is completed, and so five more have been ordered. The object is not to give the Center the role of distribution agency, but rather to make possible the study of Pathsounder users with a lot of experience, a most important part of the evaluation effort.

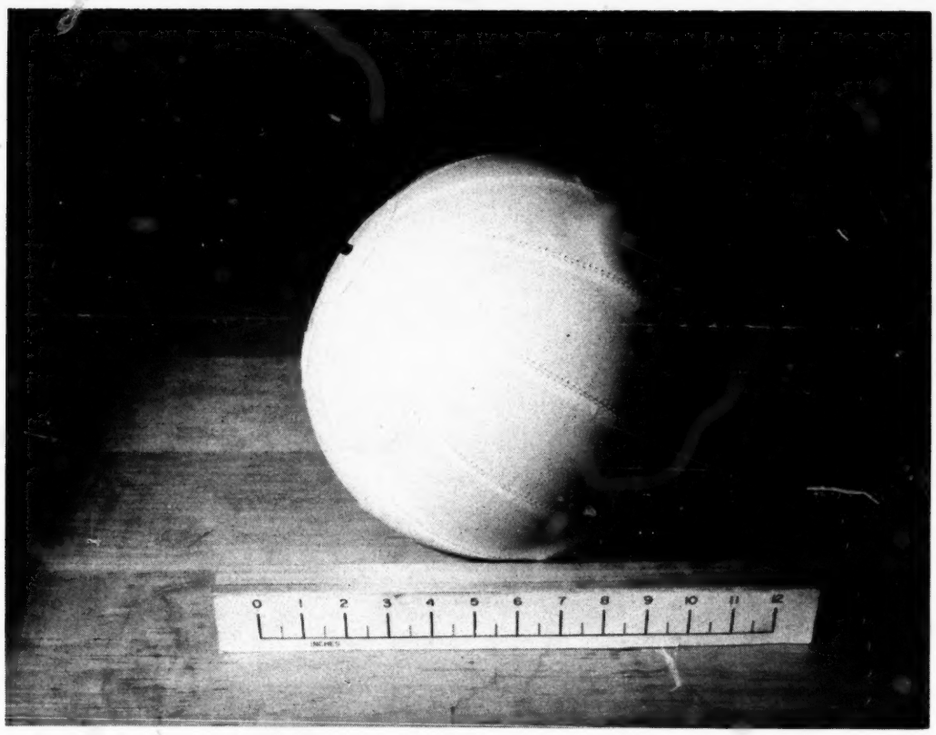
Description of the Pathsounder



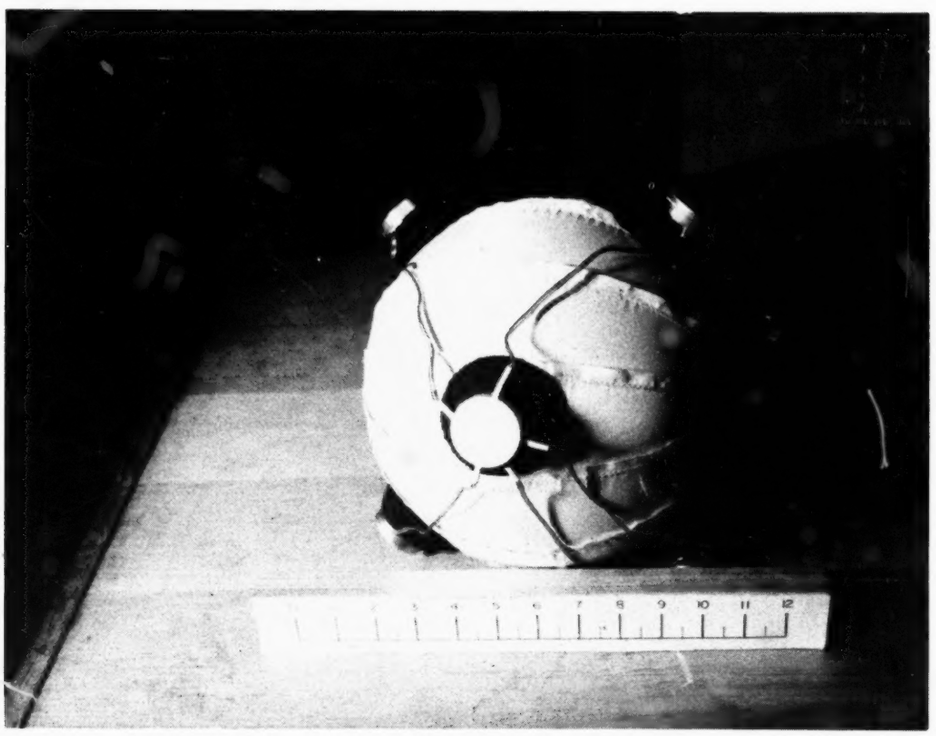
The sketch shows the control panel of the H model sounder. The ON-OFF switch turns the sounder on when pushed forward (away from the user's chest). The RAMP switch affects the loudness of outer-zone sounds. It is normally pushed forward in a noisy location. The LOUD-SOFT switch controls the volume of all display sounds, and the forward position is for loud. An effort has been made on these units to have all switches function such that "Forward is Safest". Safest means that the unit is on, volume loudest, greatest range in the case of special switches installed to alter range limits, etc. The charging jack allows the sounder to accumulate power for approximately 8 hours use from a separate charger pack. The remote-audio jack is provided for special projects: feeding the display sounds to a tape recorder, radio data-link, special speaker or headset, etc.

Sound Source Ball

During the spring of 1968, a Sound Source Ball was loaned to a Physical Education teacher, Michael Cataruzolo, at Perkins School for the Blind, for student use, primarily in the elementary school Physical Education program. The ball was essentially the latest design of the Woodie Flowers Sound Source Ball (70249-3)[4] except for the use of a punching bag bladder. Since that time round bladders have been obtained. While at Perkins the ball was used for several different types of games, both indoors and outdoors.



Sound Source Ball



Sound Source Ball, with internal electronics visible

One of the games was baseball as played by the lower school boys. They played in a paved court, normally used for roller skating. In their usual game, a soccer ball is bounced to the batter who swings with his arms. The bounce helps the batter to locate the ball. With the Sound Source Ball it was possible to eliminate the bounce and the ball was pitched directly to the batter. Most students could catch the ball, some on the fly. The sound source ball added greater flexibility to the game and increased the students' enjoyment of the game.

The same group of boys used the ball for soccer, which was played on a grass field. The students with the better mobility capability could run up to the ball and kick it on the run. Most of the others could locate the ball, but could not kick it with a high degree of certainty. One student -- a very poor traveler -- could not even locate it.

The ball was also used by this group of boys in basketball. Again there was the wide variety of performance of the students, but the indoor environment added a new problem, sound reflections from the walls. In the new gym, approximately regulation size, the performance of each boy was worse than in the older gym or outside. This difficulty apparently was caused by reflections from the hard walls of the new gym. These walls are of heavy wooden doors or solid masonry. The old gym is smaller but mats hung along parts of the length of the long walls do much towards deadening the room. A metronome is mounted just behind the backboard and slightly above the basket as a basket locator. The wall and floor reflections have less effect on the basket locator than on the sound

source ball because the short duration of the metronome pulse, the fixed geometry of the metronome in the room, and the experience of the players with the metronome all reduced the effects of the reflections.

The high school boys also used the ball in their baseball games. In this game a softball bat is used by the batter. During one of these games, the ball was batted into a tree, where it became caught on a snag. This ripped the cover and punctured the bladder. Before this accident the ball survived 3 weeks of heavy usage without difficulty.

Mounting the electronics via shaped rubber pads on the skin appears the optimum method of those investigated previously. These pads affect the rebound or bouncing characteristics only slightly. A student can dribble the ball with no difficulty, but on long bounce passes the ball does not always bounce true. The dynamic balance of the ball is sufficient for the ball to be passed or thrown on a line without noticeable deviation.

The skin and bladder of the ball require further development. They must be transparent to sound, resistant to abrasion, and puncture proof. Since the last criterion is not met the present design is serviceable only in environments selected such that there are no sharp objects, twigs, thorns, small stones, etc. But this brief exposure to students demonstrated that the ball has a definite place in the blind students physical education and play programs, even in its present state of development.

IV. Proposed Work for Calendar Year 1969

Embosser Field Test and Evaluation

The use of the time-shared computer as the means of providing instantaneous braille translation from keyboard input at remote braille consoles has been demonstrated a number of times at the Center. The Center proposes to expand the demonstration of this capability and thereby explore the economic and operational aspects of extended applications of the system. We plan to investigate the installation of several braille terminals to be located in selected public or private schools in the Boston area as well as in selected industrial locations where the effectiveness of already employed blind persons would be enhanced by access to immediate braille. Several terminals simultaneously operational over a select time-period will be used to gather detailed information on the use and cost of such a system as well as deriving peripheral benefits from the evaluation, reliability and accuracy testing of both the brailler machines and the computer translation program.

Straight Handle Folding Cane

Cane users and peripatologists have urged the development of a straight-handle folding cane. Subsequently a prototype model was designed and assembled by SAEDC personnel. It is therefore proposed that a straight-handle folding cane be developed and distributed for comparative evaluation according to the guidelines established for the crooked-handle folding cane. [Note: see the section on crooked-handle

folding canes.]

The program will distribute canes to agencies and subjects, with the qualification that the latter will be experienced with folding and rigid cane mobility techniques. In addition to the assembling and distribution of the straight-handle folding cane to a select group of evaluators it is proposed that a revised questionnaire be developed for this program which will be specifically tailored to collect data on the usefulness, acceptability, desirability and appropriateness of the straight-handle folding cane.

Electrified Perkins Brailler

Plans have been made to manufacture and distribute a limited number of electrified Perkins braillers for evaluation purposes. [Note: The brailler has been described in section III] The evaluation process will include the preparation of a questionnaire to be distributed with each brailler. Subjects will be selected from volunteer braillist groups, blind professionals and students. The evaluation period for this program will extend for approximately one year, during which time each participant will be required to operate the machine for a period of about two months.

Lindsay Russell Pathsounder

The Center has in its possession several monaural "pathsounders",

ultrasonic mobility devices designed as supplementary aids for cane travelers. The pathsounder travel technique is in an experimental stage, and the Center's role has been that of teaching the technique, evaluating its usefulness, suggesting technical modifications of the basic instrument, and so on.

At the end of fiscal year 1968 (Dec. 31, 1968), several qualified teachers of cane travel have become experienced in the use of the pathsounder and have instructed a small number of blind clients in this technique. A start has been made in the direction that appears most sensible for this program: the introduction of pathsounder training to a carefully selected group of cane users, and the development of a small cadre of teachers -- general mobility trainers in their own right -- who are well grounded in pathsounder training.

Several purposes have been served:

1. The device has received a preliminary evaluation, feedback has become available to the Center and its staff from the realities of street travel experience, and from this data some early assessment of the aid's usefulness has been made.

2. An introduction of this travel aid has been made to the orientation and mobility community.

In accordance with this thinking, the proposed pathsounder activity of the Center is to continue what has been started during the present year: to expand the scope by increasing the number of trainers which will allow an increase in the number of trained subjects. From the results of this evaluation a training manual will be prepared and, in

addition, a conference or symposium may be organized for mobility teachers interested in learning the new technique.

Sound Source Ball

A great deal of interest has been aroused in the agencies and community of the blind by the introduction and development of the M.I.T. "Sound Source Ball". [Note: See the section on Sound Source Ball.] The "Sound Source Ball" originated as a thesis project under the guidance of the Mechanical Engineering Department at M.I.T. The prototypes are presently undergoing severe reliability testing. Many inquiries are received at the Center for Sensory Aids Evaluation and Development from agencies and schools for the blind as to the status and availability of the Sound Source Ball for distribution and testing. The Center proposes to manufacture and distribute a limited number of the present design of the Sound Source Ball to a select group of evaluators. It is planned that interested groups, agencies and schools will participate in this evaluation program, however the list of participants has not yet been completed.

V. Administrative Structure

The Director and staff of the Center are responsible to the Mechanical Engineering Department at M.I.T. In addition, all Center projects are submitted to its Steering Committee for approval.

Members of the Steering Committee participate in the day-to-day activities of the Center as consultants in their areas of individual specialization (Sensory Psychology, Mechanical Engineering, Electrical Engineering, Rehabilitation, Special Education, etc.) Also, this committee is divided into behavioral science and engineering task forces to assist staff members in designing and carrying out major projects.

The Advisory Committee to the Center maintains more effective contact for Center staff with research and rehabilitation facilities throughout the country. Their other main function is to join with the Steering Committee and Center staff to develop optimum planning.

Members of the Steering and Advisory Committees are listed below:

National Advisory Committee

Dr. R. A. Bottenberg, Air Force Personnel Lab., Lackland A.F.B., Texas
Mr. Leon Harmon, Bell Telephone Labs, Murray Hill, New Jersey
Prof. E. Foulke, Department of Psychology, University of Louisville
Prof. R. H. Gibson, Department of Psychology, University of Pittsburgh
Dr. H. Goldstein, Children's Bureau, H.E.W.
Dr. M. D. Graham, American Foundation for the Blind
Prof. J. G. Linvill, Electrical Engineering Dept., Stanford University
Prof. I. F. Lukoff, School of Social Work, Columbia University
Dr. C. Y. Nolan, American Printing House for the Blind
Dr. R. A. Scott, Sociology Department, Princeton University
Dr. M. R. Rosenzweig, Psychology Department, Univ. of California, Berkeley

Dr. W. P. Tanner, Jr., Sensory Intelligence Lab, University of Michigan
Dr. B. W. White, Psychology Department, San Francisco State College

Steering Committee

Mr. C. Davis, Perkins School for the Blind
Prof. R. Held, Psychology Department, M.I.T.
Prof. S. J. Mason, Electrical Engineering Department, M.I.T.
Prof. A. W. Mills, Psychology Department, Tufts University
Prof. R. B. Morant, Psychology Department, Brandeis University
Mr. J. F. Mungovan, Massachusetts Commission for the Blind
Dr. L. H. Riley, American Center for Research in Blindness and Rehabilitation
Dr. O. Selfridge, Lincoln Lab, M.I.T.
Prof. T. B. Sheridan, Mechanical Engineering Department, M.I.T.
Dr. M.L. Simmel, Psychology Dept., Brandeis University
Prof. R.W. Mann, (Chairman), Mechanical Engineering Department, M.I.T.

VI. Activities

Industrial Cooperation with the Center

In accordance with the statements outlining the initial contract agreements with SRS the Center has devoted its resources to the location of new devices for evaluation, to the involvement of others in developing new devices and to the development of new sensory aids for the blind. In order to fulfill the implicit purpose of these agreements an essential step has been included in the scope of our activities. The goal of this program is to explore industrial involvement and participation in the production of devices in the area of sensory aids for the blind.

The development and evaluation of aids or devices, by them-

selves, will not put the aids in the hands of the blind user. However this process helps to sort out the appropriate and useful aids which then can be applied as serviceable tools. The Center is only geared to handle a very limited production of any of these devices and then only for evaluation purposes. For example, the crooked handle folding cane, the electrified Perkins Brailler, the High Speed Braille Embosser, and the Sound Source Ball. The responsibility for production must be accepted by manufacturers. Therefore the Center's present role is to confront industry and acquaint them with the facts related to the production of sensory devices: 1) the necessity to align the product with the capability of the firm; 2) the extent of initial investments necessary to become involved; 3) marketing and distribution problems. The Center is now willing to explore with any responsible industrial or manufacturing organization or firm the nature of these problems. The Center is also willing to explore joint participation efforts in order to allow industrial cooperation and involvement in products and development program.

Guests Hosted by the Center

The following enumeration of guests is a partial listing of people and members of organizations received at the Center as part of its seminar, consultation, industrial, interest group and other educational activities:

Kaarlo Virkki	Judith Rutberg	Paul Touchette
Irma Virkki	Jan Broadfort	George Barros
Paul Weene	Robert Friedman	John F. Dunn, Jr.
Len Smollen	Lois Matthews	John O'Connell
John H. Stewart	June A. Zalewski	Richard von Handorf
Richard Hirsh	Mary T. Dolan	J.F. McClughan
Paul R. McDuke	Irene Taube	Joseph Kopitsky
John Eichorn	Martha Cole	John Watts
Robert McEntire	Carol Bierman	Robert Streight
Robert Cunio	Jim Lyons	D. Worlton
Edward Lantz	Loretta McGraw	Yasuhiro Kizuka
Stephen Digel	Caroline Culpepper	Mr. Lang
Richard J. Roper	Mary Greene	Daphne Fox
Mrs. Barry Sakow	Mary Daily	Dr. Paul Bach-Y-Rita
Filomena Gargiulo	Jane McCrosky	Allen Downing
Michele Stephens	Maurice Tretakoff	J. Robert A. Lemieux
Gary Kriss	Mrs. Joan Smith	George Harris
Lester Lehon	Victoria Eastman	Roland Langlais
Phyllis Lehon	Donna Cribbs	Hans Rasmussen
Whiting Wicker	Jasha Levi	Jorgen Vinding
Gwendolyn Gover	Theodore Nathanson	Charles A. Hallenbeck

VII. Seminars, Presentations, Conferences and Publications

Seminars and Presentations
(See sample agenda in appendix 7)

1. A one-day seminar was held for the graduate peripatology students from San Francisco State College. January 1968
2. A staff member spoke to the Blind University Group about sensory aids activity at a supper engagement. March 11, 1968.
3. M.I.T.-Harvard Task Force in sensory aids at the Ramada Inn. June 19-21, 1968
4. A two-day seminar summer session was held at M.I.T. for the graduate special education students of Columbia University, School of Education, Special Education Department. Speakers included mechanical engineering staff, sensory aids staff, electrical engineering staff and Research

Laboratory of Electronics staff. August 19-20, 1968.

5. A staff member spoke at a teacher's conference in special education at Northern Illinois University at DeKalb, Illinois, on the M.I.T. High Speed Braille Embosser. November 13, 1968.
6. A demonstration was held at the Boston Sheraton Hotel of the M.I.T. High Speed Braille Embosser and the Blanco tape reader, as a major contribution to the Easter Seal Convention. November 16, 1968.
7. The director of the Center spoke to the Blind University Group about an overview of the current activities of the Center at a supper engagement. November 20, 1968.
8. The director spoke to the Eastern regional counselors of the Commission for the Blind in Boston on forthcoming activities of the Center. November 21, 1968.
9. An overview of the Center's activities and a discussion of involvement and participation was held with the Steering and National Advisory Committees at the Ramada Inn in a general conference. December 2, 1968.
10. A morning seminar was held at the Center for the peripatology graduate students of Boston College acquainting them with the current activities of the Center. December 6, 1968.

Conferences

1. Conference on Mobility Trainers and Technologists was held at the

Faculty Club at M.I.T. December 14, 15, 1967. Proceedings published.

2. Conference on New Processes in Braille Manufacture was held jointly with the Center and the American Printing House for the Blind in Louisville, Kentucky. February 8,9, 1968. Proceedings published.

Publications

1. Dupress, John K.; Baumann, Dwight B.; Mann, Robert W. Towards Making Braille as Accessible as Print. Report No. DSR 70249-1, June 1968. Engineering Project Laboratory, M.I.T.

VIII. Special Conferences

Visits were made and special conferences held with:

1. IBM - June 6, 1968, Poughkeepsie, New York.
2. Veterans Administration, Howard Freiburger - August 8, 1968, New York, New York.
3. Haskins Laboratories, Dr. Frank Cooper - August 8, 1968, New York, New York.
4. American Association of Workers for the Blind - July 7,8, 1968, Toronto, Canada.
5. University of the Pacific, Dr. Paul Bach-y-Rita - September 23, 1968, San Francisco, California.
6. Stanford Research Institute, Drs. Bliss and Linvill - September 24, 1968, Menlo Park, California.
7. Recording for the Blind, Jasha Levi - October 7, 1968, New York, New York.
8. American Foundation for the Blind, Mr. Clark and Dr. Graham - October 7, 1968, New York, New York.
9. Riverside Research Institute - October 7, 1968.

10. Albert Einstein Institute, Drs. Vaughan and Shimmel - October 17, 1968, New York, New York.
11. Health, Education and Welfare, Social and Rehabilitation Service, Dr. Deno Reed - October 29, 1968.
12. Northern Illinois University - November 13, 1968, DeKalb, Illinois.
13. Washington Univ. , Drs. Theodor Sterling and Charles Hallenbeck - November 14, 1968, St. Louis, Missouri.
14. American Association of Workers for the Blind - November 21, 1968, Harrisburg, Pennsylvania.
15. National Institute for Neurological Diseases and Stroke, Dr. McNichols - December 11, 1968.
16. American Printing House for the Blind, Mr. Davis - Louisville, Kentucky.

IX. Summary

A summary of the activities of the Center for the fiscal year ending December 31, 1968, can be reviewed in the following manner:

1. The feasibility of a simultaneous braille and inkprint version of a novel was demonstrated through the publication of The East Indiaman by E. K. Meacham.

2. The design of the electrified Perkins Brailler has been completed for evaluation purposes.

3. A Model 3 version of the M.I.T. High Speed Braille Embosser has evolved through re-design efforts.

4. A pilot demonstration program for producing limited copy braille text was initiated and completed.

5. Assembly and distribution of a crooked-handle folding cane has been completed for evaluation purposes.

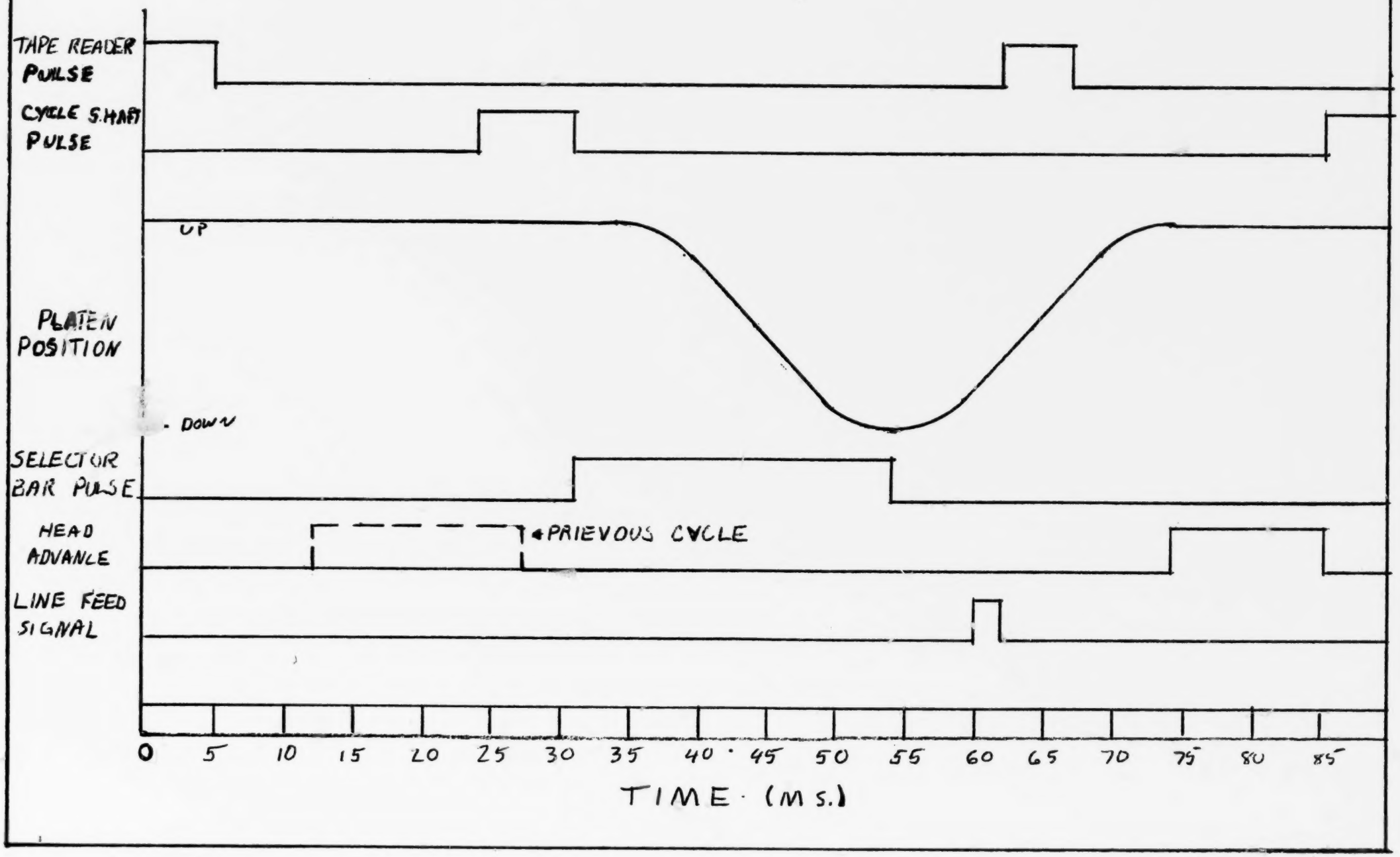
6. The Sound Ball was field tested at Perkins School for

the Blind.

7. An expanded Pathsounder evaluation program was undertaken including the training of peripatologists in Pathsounder techniques and the gathering of data as part of an evaluation program.

X. Appendices

MODEL 3 BRAILLER
TIMING DIAGRAM



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Appendix 1.

Appendix 2. Model 3 Timing Control

The Model 3 Mk 2 Electronics has four operation modes, Manual, Tape Reader, EQIDOT Exerciser, and BIDOT Exerciser. The primary mode is the tape reader. The input device is a Friden SP-2 Punch Paper Tape Reader. This reader has an approximate 23 millisecond delay from the time it is pulsed until data is available. This strongly influences the timing and requires some operations to be completed after the tape reader has been pulsed for the next cycle. In all cases operations that must inhibit the tape reader start before the next tape reader pulse such that the tape reader pulse may be inhibited.

The cycle shaft is operated at 1180 rpm or 50.8 ms per revolution. The actual time for one complete cycle is approximately 60 ms because of the finite starting and stopping time. Another constraint is that the head advance or paper feed operation must not be done when the platen is in contact with the head or embossing pins.

The initial step is to pulse the tape reader. The data is examined and the operation follows one of three paths, according to the coding. The first kind is Emboss. For this level eight has a "0", and the desired dots in the braille cell have a "1" in the corresponding levels. After 1 ms delay from the time of initially receiving data, the cycle clutch is pulsed at 24 ms. At 34 ms selector bars corresponding to the desired braille code are energized for 24 ms. The platen driven by the cycle shaft reaches its maximum downward excursion at 54 ms. The head release occurs at 74 ms and is done mechanically.

The second group of operations are the "Machine Functions." For these operations level 8 has a "1" and at least one other level has a "0".

Space. Levels 7 and 8 both have a "1". The cycle shaft is triggered at 24 ms, but all other operations except buffer storage reset and the next reader pulse are inhibited.

Line Feed. Levels 1, 3, 7 and 8 have a "1". The line feed solenoid is energized at 24 ms. All other operations are inhibited until the operation is complete. The buffer storage is reset at the end of the operation.

Carriage Return. Levels 1 and 8 have a "1". At 24 ms, the CR Flip Flop is set and the cycle clutch triggered. During the time the CR FF is set the cycle clutch is retriggered at 62 ms intervals until the CR FF is reset by the Automatic Line Feed. The buffer storage is reset at the end of the operation.

Automatic Line Feed. After the 38th cell of a line is embossed the brailler provides an ALF function. This circuit is enabled when the End-of-Line switch is closed by the head in the last cell. The LF solenoid is then energized at a time when the platen has just cleared the embossing pins. This time is determined by a delay circuit started when the cycle clutch is pulsed. All other operations are inhibited during the ALF function.

Error. All levels, 1 through 8, have a "1". All operations of the brailler are inhibited except the buffer storage is reset at 50 ms and the tape reader is retriggered at 62 ms.

NUMBER OF CANES

2 4 6 8 10 12 14 16 18 20 22

GLIDE NYLON TIPS

CANE LENGTHS

34 36 38 40 42 44 46 48 50 52 54 56

Appendix 4. Chart I

No. of Canes	Agencies Used in Cane Evaluation
3	Boston College, School of Education, 96 College Road, Chestnut Hill, Mass. 02167
3	Boston Public Schools, 220 Warren St., Roxbury, Mass. 02119
2	Florida State University, College of Education, Tallahassee, Florida 32306
5	State of Hawaii, Dept. of Social Services, 1901 Bachelot St., Honolulu, Hawaii 96817
8	V.A. Hospital, Bldg. 148, Hines, Illinois 60141
2	I.H.B., P.O. Box 104 Central Station, Jamaica, N.Y. 11435
1	Illinois Visually Handicapped Institute, 1151 South Wood St., Chicago, Ill. 60612
8	Mass. Assoc. for Adult Blind 120 Boylston St., Boston, Mass. 02116
5	New Mexico DHEW, Div. of Services for the Blind 321 Fifth St., S.W., Albuquerque, New Mexico 87102
3	N.D. Div. of Vocational Rehabilitation, Occupational Therapy Bldg., Box 8117, Grand Forks, N.D.
8	Palo Alto V.A. Hospital, 380 Miranda Ave., Palo Alto, Calif. 94304
6	St. Paul's Rehabilitation Center 770 Centre St., Newton, Mass. 02158
2	R.N.I.B. 224-6-8 Great Portland St., London W.1, England
10	S.F. State College, School of Education 1600 Holloway Ave., San Francisco, Calif. 94132
4	Western Michigan University, Institute of Blind Rehab., Kalamazoo, Michigan 49001
7	Individuals: Boston - 1, Kentucky - 1, New York - 3, Washington - 1, Washington, D.C. - 1.

Appendix 5.

INSTRUCTIONS FOR ADVISORS

(N.B. These instructions are for the advisors only and are NOT to be read to the subject.)

The folding cane is constructed of the same aluminum alloy and with the same outside diameter as the VA's Typhlocane. When the cane is extended and locked, its characteristics are the same as the Typhlocane except for the additional weight of the steel tension cable and the overlapping metal at the joints. It is able to withstand the same use and abuse as a standard cane when extended and locked.

The cane may be damaged during the folding or extending operation if treated carelessly or incorrectly. The most probable causes of failure are overstress or abrasion of the cable caused by poor techniques in folding or extending the cane. One of your functions is to teach the subject the correct techniques to ensure that the service life of the cane is not reduced. The cautions in the detailed instructions are to point out to you where carelessness or improper technique will cause undue wear or strain. Do not overemphasize these to the subject in such a fashion as to make them apprehensive.

Please be familiar with the accompanying material: Release, Introduction, General Information, Pre-Test Questionnaire, Post-Test Questionnaire forms, and Malfunctioning Folding Cane Report.

Practice the folding and extending operations of the cane as described below until you can do it smoothly and rapidly.

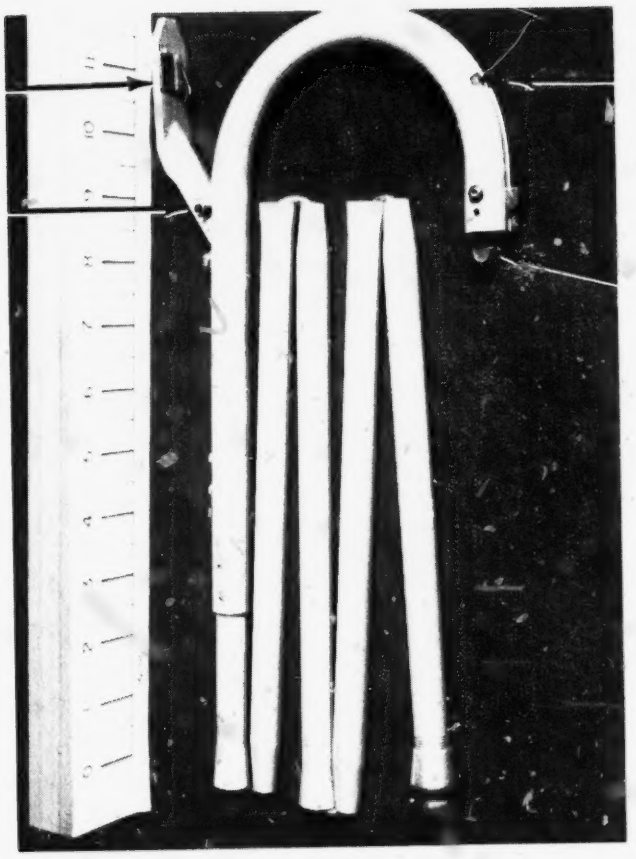
I. Read the Introduction to the subject unless he read it in braille.

II. Have the subject understand and sign the Release. The technical custody of the canes will remain at the Center, but they will not be recalled if the subject is actively using them. The cane is not to be given to the subject unless the Release is understood and signed.

III. Let the subject explore the cane, starting with the handle when the cane is folded. Name each part as it is explored by the subject. Be sure the subject notes each part labeled in Figures 1 and 2.

locking lever

locking lever pin



detent

locking

FIGURE 1. CANE FOLDED

locking lever pin in detent

locking lever

locking pawl

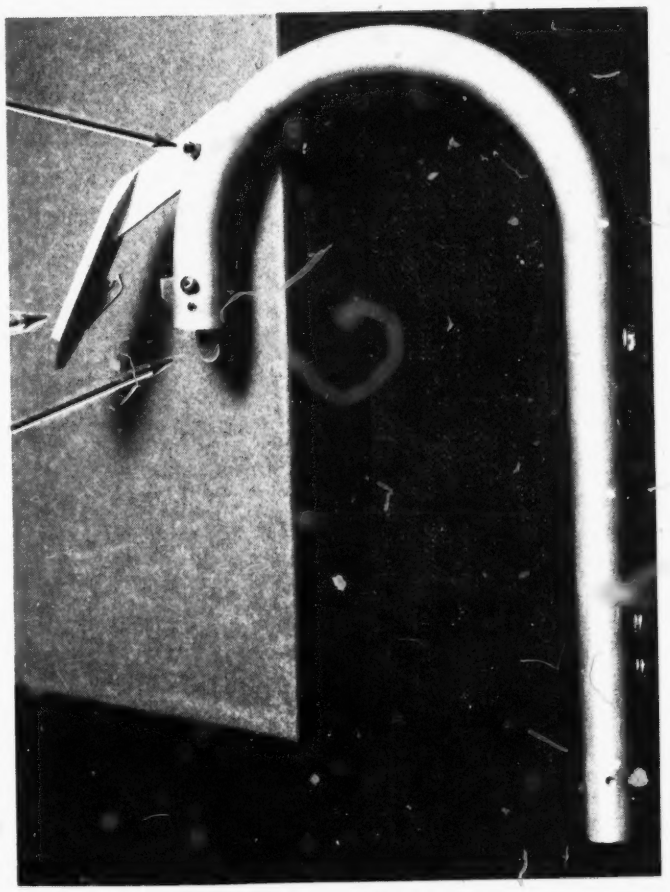


FIGURE 2.a. CANE HANDLE, UNLATCHED

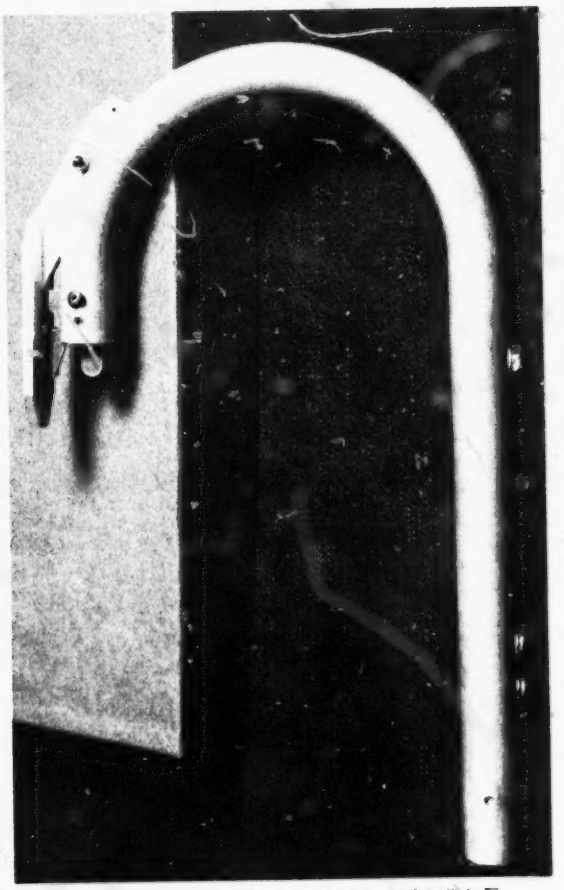


FIGURE 2.b. CANE HANDLE, LATCHED

IV. Assemble the cane and let the subject continue to explore the cane. Describe any additional parts the subject desires. Let him try the cane for rigidity.

V. Have the subject fold the cane under your close supervision. Describe each step. Explain the reasons for each step if necessary.

1. Depress the locking pawl. This unlatches the locking lever and releases the tension cable. (Figure 3)

FIGURE 3. SUBJECT DEPRESSING THE LOCKING PAWL

2. Slide the locking lever around the curvature of the handle until it comes to a stop at the end of the slot.

3. Hold the handle horizontally palm down with the crook away from the body.

4. Slide the top section up along the cable until it touches the handle. (Figure 4)

FIGURE 4. SUBJECT FOLDING THE CANE

5. Repeat for each section until all sections are held parallel to the handle.

CAUTION

It is necessary to properly distribute the slack in the cable to prevent chaffing at the joints while folding. If the sections cannot be laid parallel to the handle easily, release the sections. Make sure the locking lever is against the stop and begin folding again.

6. Store the cane in a convenient location such as a pocket or handbag.

VI. Have the subject extend the cane under your close supervision. Describe each step. Explain the reasons for each step if necessary.

1. Grasp the handle and let the sections drop. They will fall into place along the cable.

2. Shake gently to help seat the sections.

3. Hold the handle vertically and, with the thumb, slide the locking lever upward and around the curvature of the handle until the pin on the locking lever clicks into its detent. (Figure 5) If resistance is felt, the two top sections may not have seated properly. With SLIGHT pressure on the locking lever, wiggle the handle about the vertical until the top joint seats. Or, with the other hand, position the top joint. The pin will not slip easily into the detent until the joints are seated correctly.

FIGURE 5. SUBJECT SLIDING THE LOCKING LEVER UP AROUND THE HANDLE

a. at the start

b. at the center

c. at the end when the locking lever pin is seated

CAUTION

Do not force the locking handle pin into the detent unless the cane is completely assembled. To do so will strain the cable and will lead to premature failure.

4. Press the locking lever towards the handle until the locking pawl seats. (Figure 6) The cane is now ready for use.

VII. Let the subject repeat the folding and extending operations under your supervision until satisfied of his proficiency in these operations. Use more than one session if necessary.

VIII. Administer the General Information and Pre-Test Questionnaire.

IX. Give the subject the shipping container and Malfunctioning Folding Cane Report form in case the cane must be returned for repairs.

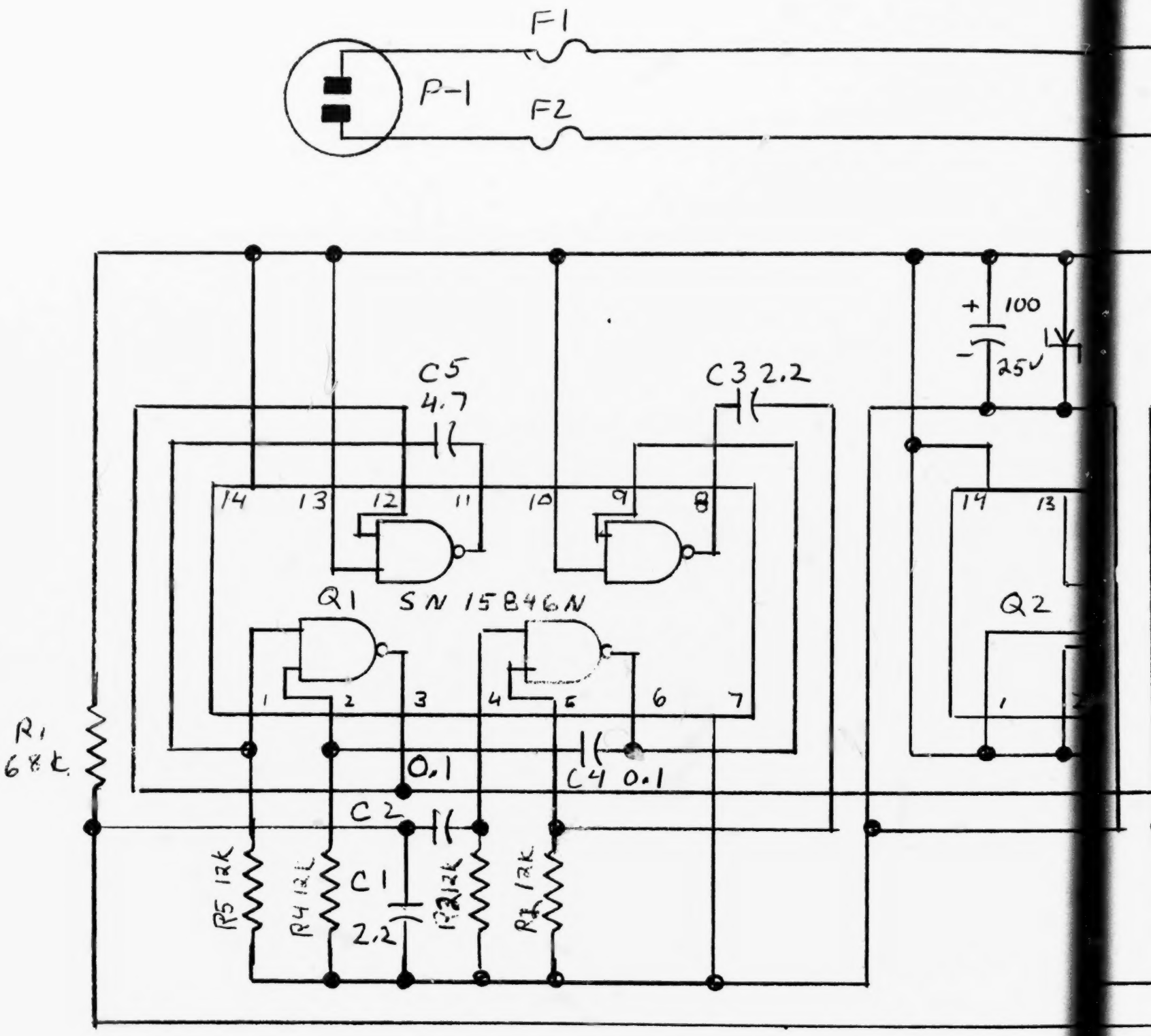
X. After two months, administer the Post-Test Questionnaire. If possible, maintain contact and help the subject with additional reports as necessary.

FIGURE 6. SUBJECT LOCKING THE CANE

Do not hesitate to contact us for any assistance or information you require. Any comments or suggestions in the evaluation, design, or other aspects of the cane will be appreciated.

PLEASE do not let the subject use the cane unless he is proficient in folding and extending it and has signed the Release. Thank You.

The Sensory Aids Evaluation and Development Center
292 Main Street
Cambridge, Massachusetts 02142
ph. (617) 864-6900 Ext. 5331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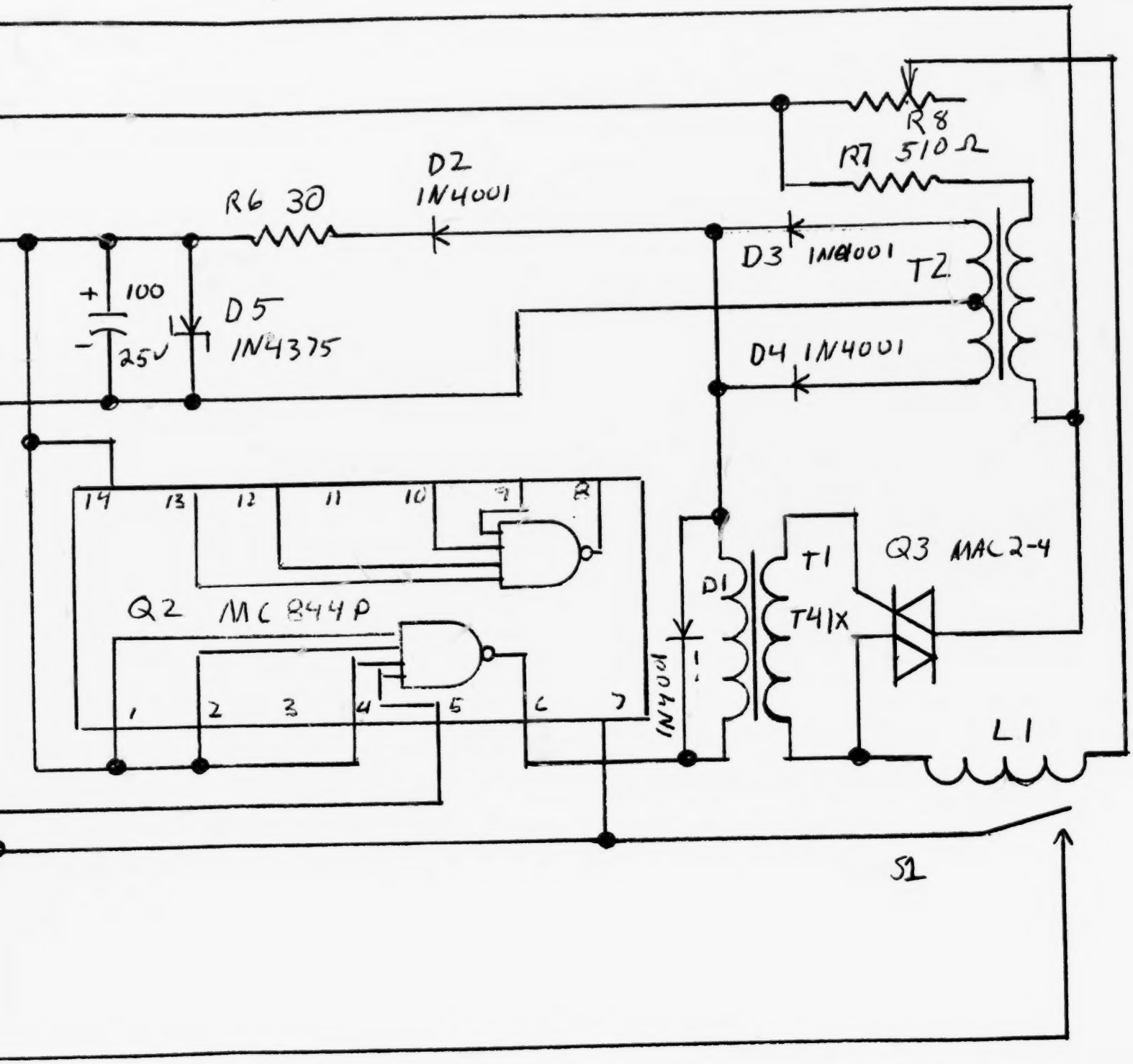
lectrified Perkins Brailler Triac Driver Schematic

DATE	SYM	REVIS



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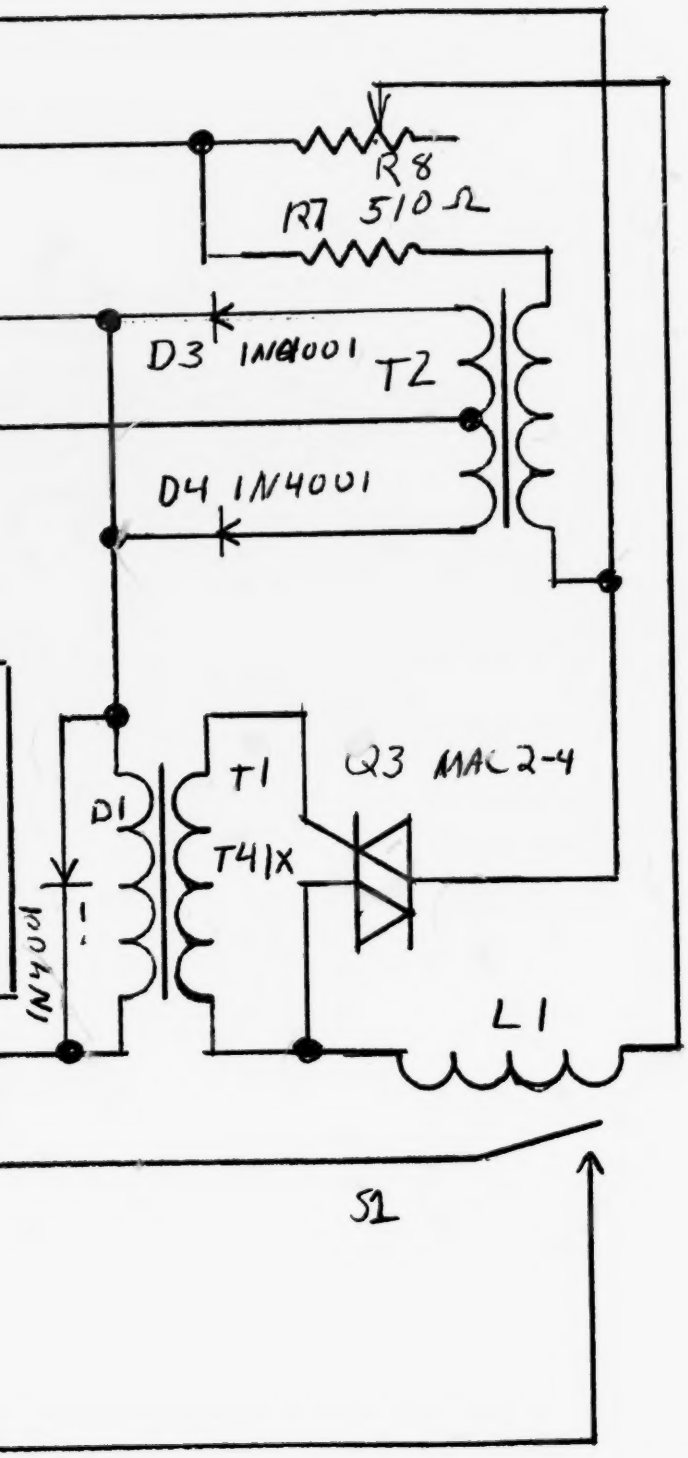
DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.



TOLERANCES (EXCEPT AS NOTED)			
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Appendix 7.

Sample Seminar Agenda

Sensory Aids Evaluation and Development Center
292 Main Street
Cambridge, Mass. 02142
864-6900 x5331

I. Introductory Remarks
   - A. History and background of the Center
   - B. Current funding
   - C. Objectives and goals of the Center

II. Organization of the Center
   - A. Permanent staff
   - B. Consulting staff
   - C. Committees
     1. Steering
     2. National Advisory

III. The Center's initial charter
   - A. Evaluation of existing sensory aids and devices
   - B. Location of new aids for evaluation
   - C. Encouraging others to become involved in sensory aids
   - D. In-house development of sensory aids
   - E. Development of training procedures for devices
   - F. Involvement in behavioral research under field test conditions
   - G. Development of standards for evaluation purposes

IV. Review of current activities at the Center
   - A. Crooked handle folding cane
     1. History and comparison with other canes
     2. Distribution and selection
     3. Evaluation process
   - B. Electrified Perkins Brailler development project
   - C. High speed brailler embosser
     1. Funded by a Hartford Foundation grant
     2. Re-design and manufacture of 20 embossers
     3. Demonstration
   - D. Pathsounder evaluation program
     1. Pathsounder demonstration
     2. Kay aid demonstration
   - E. Simultaneous braille and inkprint publication of <u>The East Indiaman</u> by E. Meacham
   - F. The Sound Source Ball

1. Description and demonstration
2. Field testing

V. Continuation Programs at the Center

A. Straight handle folding cane project
   1. Development and test
   2. Distribution and evaluation
B. Electrified Perkins Brailler program
   1. Distribution of 10 braillers
   2. Development and evaluation process
C. M.I.T. High Speed Braille Embosser field test and evaluation program
   1. Terminal at the Center
   2. Simultaneous feild test operation
   3. Pilot demonstration program for the Perkins School for the Blind
D. Expanded Pathsounder Evaluation program
   1. Large scale trainee program
   2. Instruction manual
E. Manufacture and distribution of Sound Source Ball
   1. Selection of test facilities
   2. Distribution of 10 Sound Source Balls
F. Other programs
   1. Mono-type compositor's tape
   2. Storage of compositor's tape

VI. Seminar activities of the Center

A. Columbia University Teacher's College, School of Special Education - August 19, 20, 1968
B. Northern Illinois University - November 13, 1968
C. Easter Seal Convention - November 16, 1968
D. Blind University Group - November 20, 1968
E. Commission for the Blind - November 21, 1968
F. Steering and National Advisory Committee joint meeting - December 2, 1968
G. Boston College, School of Peripatology - December 6, 1968

VII. Conferences

A. Mobility Conference - "Proceedings Conference for Mobility Trainers and Technologists" December 14, 15, 1967
B. Braille conference - "Proceedings Conference on New Processes in Braille Manufacture" February 8, 9, 1968

VIII. Industrial Participation with the Center

A. For purposes of manufacturing sensory aids devices
B. Stimulation of joint projects
C. Consultation with the Center
D. To stimulate new ideas

IX. Closing Remarks

XI. References

1. Proceedings: Conference on New Processes for Braille Manufacture, 1968, organized and sponsored by the Center for Sensory Aids Evaluation and Development, M.I.T., Feb. 8 & 9, 1968.

2. Proceedings: Braille Research and Development Conference, sponsored by the Sensory Aids Evaluation and Development Center, M.I.T., Friday, 18 November, 1966.

3. Proceedings: Conference for Mobility Trainers and Technologists, sponsored by the Sensory Aids Evaluation and Development Center, M.I.T., December 14 & 15, 1967.

4. Woodie Flowers: A Sound-Source Ball for Blind Children, Report No. 70249-3, Engineering Projects Laboratory, Department of Mechanical Engineering, M.I.T., June 1967.